DOCUMENT RESUME

ED 150 320 CE 014 465

AUTHOR Baath, John A.; Mansson, Nils-Ove
TITLE CADE--A System for Computer-Assisted Distance Education: Development, Design, and Evaluation of the System.
INSTITUTION Hermods School, Malmo (Sweden).
SPONS AGENCY Swedish Board of Technical Development, Stockholm.
PUB DATE Apr 77
NOTE 62p.; Appendexes may reproduce poorly

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; *Correspondence Study; *Educational Development; Educational Innovation; Educational Technology; Experimental Teaching; Foreign Countries; *Individualized Instruction; *Instructional Improvement; Instructional Innovation; Instructional Media; Instructional Programs; Instructional Systems; Instructional Technology; *Program Development; Program Effectiveness; Program Evaluation; Student Reaction; Systems Development; Telecommunication
IDENTIFIERS Sweden

ABSTRACT

A three-stage, computer-assisted distance education (CADE) project was undertaken to design a prototype of CADE that would improve the two-way communication in correspondence education in three respects: (1) the quality of the tutors' comments as to feedback effectiveness and motivational aspects, (2) the turn-round time of students' solutions to assignments, and (3) the quality of assignments. In the first two stages of the development work, the parts of the computer-assisted correspondence instruction were simulated by means of an optical reader and an operator at an automatic typewriter. The third stage involved developing and evaluating a real computer-assisted distance tutoring system and studying experimentally the effects of explicitly informing part of the students about the role of the computer in the teaching system. The final outcome is a system where the students' solutions are corrected by an optical reader. The results are analyzed by a computer which types out individualized comment letters to the students. The results of evaluating the system include the following: (1) Practical experience of the functioning of the system has been very positive, and (2) student responses to questionnaire items were positive regarding the answer forms, the turn-round time, the use of multiple choice as compared to traditional questions, and feedback comments. (EM)

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CADE — a system for Computer-Assisted Distance Education

Development, design, and evaluation of the system

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Hermods Skola

CE 014 465

Hermods Skola
205 10 Malmö

Författare John A Bååth
Nils-Ove Månsson

Layout Marianne Törnvi

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Preface

Let us assume that you have applied for a correspondence course and that you have received the course material in due order and started your study full of expectations. Let us also assume that, when you come to the assignments for submission, you find that all questions are of multiple choice type. To be able to show your answers to the school, you have to fill in small boxes on a blank form for optical reading. After a few days you receive a letter, written out by a computer, with comments to your assignment solutions.

How would you feel about correspondence teaching of that kind?

Of course, we do not know. But if you react in the same way as a surprisingly large majority of our computer-instructed students appear to have done, then you would certainly approve of it. In this report, we have tried to describe CADE, our system of Computer-Assisted Distance Education. You will find chapters dealing with

1 the background of the project – why some of us at Hermods began to think along the lines of a computer-assisted form of home study

2 the three stages of the project

3 the system design – which functions we have allowed the computer to take over, the roles taken by the tutors (instructors) and the students respectively, the design of the comment letters to the students, etc.

4 the design of an investigation of how the system works and how the students like being taught by a computer

5 the results of the investigation

6 a discussion of the results and the overall usefulness of the system.

The work on CADE started in 1970 within Hermods' research and development group. Rune Flinck, assistant professor at the department of education, University of Lund, gave us much valuable help as consultant. Many of our colleagues at Hermods – now Liber (of which Hermods School is a division) – have taken part in the project, with ideas as well as concrete and often demanding work. In particular, we would like to mention Mona Ahlm and Carl-Gustaf Hjertsäll, who made great contributions during the earlier stages of the project. During the final stage, a stimulating co-operation on CADE has been established with NKS (Norsk Korrespondanseskole). We would like to thank all who have contributed to the project.

To a substantial degree, the CADE project has been financed by means of a grant from the Swedish Board for Technical Development (STU).

The CADE system is marketed by Hermods School and NKS.

Malmö, April 1977

John A. Bååth
Head of the project

Nils-Ove Månsson
Assistant head of the project

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BACKGROUND

Two-way communication in correspondence education

Distance education can be defined as "... the family of instructional methods in which the teaching behaviors are executed apart from the learning behaviors ..." (MOORE, 1973, p. 664). Thus, what distinguishes distance education from other instructional forms is, quite simply, the physical separatedness of learner and teacher.

Correspondence education is a variety of distance education. Correspondence education is distinguished by "... two-way distant communication between teacher and learner by means of stored information" (NILSEN, 1969/1974, p. 54).

There are forms of distance education which, as a rule, include only one-way communication – from teacher to student. Some of these forms in addition use simultaneous transmission of information, e.g. education by radio and TV. There are also other forms which utilize simultaneous transmission of information but make two-way communication possible, e.g. telephone teaching.

Consequently, correspondence education can be characterized by the following three traits:

1 Teacher and student are geographically separated (as in other forms of distance education).

2 The distant communication between teacher and student is maintained in both directions.

3 This two-way communication is established by means of, e.g., printed books and handwritten letters, slides, discs and tapes – i.e., stored information.*)

It has been suggested that this communication between teacher and student in correspondence education is of particularly great importance with respect to the maintaining and strengthening of the student's motivation (BÅÅTH & WÅNGDAHL, 1976).

The contact between teacher and student in correspondence education is normally induced by means of assignments for submission. Among representatives of correspondence schools, assignments for submission – and the student - tutor contact implied – are supposed to fulfil a wide range of functions (BÅÅTH, 1976). The functions considered most important appear to be

- to give the students effective feedback
- to maintain/strengthen their motivation.

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*) It should of course be added that nowadays many correspondence schools, to some extent, use media which make simultaneous distant transmission of information possible – particularly the telephone. As an instructional medium, in addition to the correspondence instruction, the telephone has, however, been very little utilized by correspondence schools, at least in Europe (BÅÅTH, 1976).

It is probable that the demands on the tutor - student communication are roughly the same concerning both the motivation and the feedback function. In other words: Good tutoring would also favourably effect the student's motivation. Ausubel states:

> ... the best way of teaching an unmotivated student is to ignore his motivational state for the time being, and to concentrate on teaching him as effectively as possible ... and from the initial satisfaction of learning he will, hopefully, develop the motivation to learn more. (AUSUBEL, 1968, p. 365-366)

However, in addition to good teaching, the feeback to the student should also include comments intended directly to strengthen the student's motivation, to support and to encourage him.

The turn-round time of the student's solutions appears to be an important factor in the distant two-way communication. In an experimental study, REKKEDAL (1973) found that waiting more than a week for the return of corrected solutions affects the students' attitude to the "communication part" of their study unfavourably and diminishes the probability of their completion of the course. This result is well in accordance with what was found in the evaluation of the first stage of the CADE project (BÅÅTH, 1971b).

Many writers on correspondence education attach great importance to the correspondence tutor and his role in the two-way communication. However, it would seem that practice does not altogether correspond with this high level of theoretical appreciation (BÅÅTH & WÅNGDAHL, 1976). Hitherto, the training of correspondence tutors has – as a rule – not been very satisfactory. At many correspondence schools the tutors' fees are surprisingly low. The submission density of correspondence courses (BÅÅTH, 1975; 1976) is getting lower – at least in Europe – which entails less frequent contacts between tutors and students. The turn-round time appears to be embarassingly long at many schools. In addition, the students' attitudes to the work of their tutors are in some cases amazingly cool (GRAHM, 1969; GLATTER & WEDELL, 1971).

In this sub-chapter on two-way communication we have, up to this point, discussed the need of good, thoroughly conceived and carefully written tutor's comments to solutions in correspondence education. Such comments should include various measures taken in order to motivate the student. In addition, the feedback should be fairly prompt.

In practice, one or more of these demands are often not fulfilled. Either the tutor has no time to give both instructive and motivating comments, or the feedback is seriously delayed. At worst, the student has to wait for a long time for comments which provide him with only a minimum of feedback and support.

In this context, it would appear that better education could be a consequence of more effective administration, i.e.:

- well organized registers containing the current status of each student, and
- promptness and carefulness in working out the tutors' comments to solutions.

Evidently, this is a situation where a computer could be of good use. By letting the computer take over the matters of routine, the tutor might find exactly what he so often lacks – time to fulfil the heavy demands which are made on him.

The specific situation at Hermods in 1970

In 1970, the year when the CADE project was initiated, two internal investigations had indicated that there might be some deficiencies in our correspondence education at Hermods, as far as the two-way communication part of the system was concerned.

In a report, GRAHM (1969) had shown that a large (although not quite representative) sample of Hermods students viewed the tutors' corrections and comments as the least instructive and, in addition, least stimulating part of a correspondence course. Perhaps the most remarkable finding was that the students expressed this hardly favourable attitude to the tutors' work in spite of the fact that they rated the assignments for submission as the most stimulating part of a correspondence course.

The other study (BÅÅTH, 1970) deals with a practical experiment at the Restenäs-skolan (a "korrespondensgymnasium" with teaching of a "supervised correspondence study" type). Here too, a rather negative attitude to the tutors' work was found. Strange to say, 70 % of these students considered that a very simple key to the questions was more useful than tutors' corrections and comments. Only 10 % were of the opposite opinion. How could this be possible? Three plausible causes, which could, together, provide at least part of an explanation, were hypothesized:

1 The Restenäs students received – as a part of the practical experiment – diagnostic tests at their school; immediately after a test the key was distributed to the students. Thus, the feedback was very prompt, in contrast to what the students were used to from their traditional correspondence courses where they had to wait 10 days or more for their solutions to be returned.

2 The diagnostic tests were of multiple-choice type; the students stated that they much preferred this type of question to the conventional essay test questions.

3 The corrections and comments made by the tutors, whom they had previously had in traditional correspondence courses, were maybe not always of very high quality.

Therefore, we wanted to try out new methods in order to obtain

- quicker turn-round time
- higher and more uniform quality of the comments to students' solutions.

Multiple-choice questions seemed to be one possible means of achieving these objectives.

In this situation, the utilization of advanced technical aids was near at hand, since Hermods already used a computer for administrative routines of various kinds. In addition, Hermods was at that time involved in the "Delta" project, a country-wide training course in new mathematics for about 50 000 teachers (cf. HOLMBERG, 1974). In this project, assignments of a multiple-choice type were given. The answers were given as marks on a special blank form which was read by an optical scanning machine. The results were stored in the computer.

Computers as educational aids

The explosive development of computers during the last 10-15 years has also, of course, influenced education. Not least the development of time-sharing systems has paved new ways for computerized instruction.

STIERNBORG (1972) describes a considerable number of computer applications within various parts of the educational system.

Examples of activities belonging to school administration are selection of students for restricted-entry university courses, registration of students, grade reporting and scheduling. Pedagogical information systems are used in order to facilitate planning and control of the educational process by following up the students rate of progress and study results, which are presented to the teacher in different forms on certain occasions. The computer can also be used as a calculator for example in connection with problem solving or studies in mathematic. Computerized information retrieval systems designed to search literature in most academic fields, constitute an additional example of how computers can be used in education. However, perhaps the most interesting educational use of computers is computer-assisted instruction (CAI). Drill & practice, tutorial, dialogue, inquiry and simulation are different, more or less advanced types of CAI.

CAI can be defined as a process in which exchange of information takes place between the student and the computer and thus the computer takes part of the educational process. When the computer is used for scheduling, planning and reporting, i.e. functions which are separated from instruction in the strict sense of the word, we instead talk about CMI – computer-managed instruction (ATKINSON & WILSON 1969, STIERNBORG 1972).

Most of the CAI-systems described in the literature constitute examples of dialogue systems where the computer is used on-line, which however is not an absolute demand.

CAI in distance education

Most existing on-line applications are comparatively sophisticated systems where the computer is given the function of an advanced learning machine. By using terminals connected with a telephone network system (or the like) it is also possible to carry on CAI of a dialogue teaching type at a distance. In practice, however, the possibilities are limited by shortness of terminals, transmission costs and similar problems. In the comparatively few cases where, hitherto, computer systems have been integrated with correspondence education (cf. EHIN, 1973), or distance education in general, only off-line applications have been used.

In West-Germany, Holland and Great Britain we find examples of distance education off-line systems which may be regarded as borderline cases between CMI (administration) and CAI: [illegible]kolleg (West-Germany), Teleac (Holland) and Open University (Great Britain). Common to these distance teaching systems is that the computer is used only as an evaluation aid, i.e., for marking tests and reporting test results, not as an aid in the instructional process. In all three cases multiple-choice questions and optical reading of answer blank forms is used. In addition, certain statistical analyses of the students' answers are made. This information is utlized in different ways. At the Open University and Teleac, the student obtains a report of the average marks of all tested, in addition to his own result. Course administrators and teachers are provided with cross-tabulations, item analysis data, etc.

Télé-CNAM in France has taken one further step towards CAI of an off-line type. Its computer system not only "corrects" and analyzes the students' answers but initiates sending out supplementary material as well. Such material is sent to students whose test results indicate that they need more extensive explanations and/or more simplified information. The actual type of supplementary material that a student should have depends on the mistakes that he has made. In this way, the instructional process is directly influenced by the computer system (CORMIER & DANIEL, 1975).

In his study of the use of computers in correspondence education, which concludes with a proposal of how they should be used, EHIN (1973) makes the following statement concerning the two-way communication part:

> Many correspondence institutions maintain that they offer "personalized" instruction on the premise that constructed response questions are used which are individually "hand" graded by "live" instructors. This appears to be an extremely biased self-evaluation, since in many instances tests are graded routinely by clerks or part-time instructors who periodically encounter peak workloads that cause considerable delays in feedback to the students.
>
> Routine decisions are programmed decisions and can and should be automated. Unprogrammed decisions can be flagged by an automated system for human intervention. Computer based systems are not only able to grade objective tests and annotate the scores attained, but they can also supply written feedback on both correct and incorrect test responses. An instructor's time and talents should be saved for handling unanticipated student problems and not wasted on routine, well-structured processes. (EHIN, 1973, p. 63)

As far as we are informed, only one system for CAI in correspondence education – and distance education on the whole – existed prior to our CADE system. It was developed by United States Armed Forces Institute (USAFI). The great difference in comparison with the systems previously described (with a certain reservation as concerns Télé-CNAM), is found in the output of the system. The students not only got to know their number of correct answers and their grades but also received computer-printed comments to all wrong answers. In this feedback letter individualized motivating comments were also included (BRITTAIN, 1973).

The major aims of the development of this system (called CALS, i.e., Computer-Assisted Lesson Service) was (1) to save money, (2) to improve the service to the students. The improved service meant, mainly, (a) shorter turn-round time of solutions, (b) more extensive feedback comments to the students.

An evaluation was made with respect to three main criteria – quantity of assignments submitted, number of course completions, and final test results. In addition, a study of student attitudes was made. As concerns the three main criteria, the results appeared to be favourable, particularly with respect to assignments submitted and course completions. Nevertheless, student attitudes to the CAIS system seemed to be somewhat reserved.

Recently, a similar but – with reference to the computer-printed comment letters – more primitive system was developed by the German Fernuniversität in Hagen (GRAFF ET AL., 1977).

In conclusion, we have found that there are only a minor number of computer systems within distance education. Most of them are, mainly, special cases of administrative routines, the major aim of which is to assess the students' achievements on tests. It is, however, possible to use computers for more "qualified" educational functions within distance education. A necessary condition is, however – within the foreseeable future – that objective test questions (i.e., multiple choice questions) are utilized, exclusively or to a great extent.

Multiple choice questions

This sub-chapter is, to a considerable extent, borrowed from BÅÅTH (1976). For a fuller discussion, see MÅNSSON (1976).

There has been some discussion about the didactic usefulness of objective test questions in general, and multiple choice questions (MC questions) in particular.

There is fairly common agreement upon some general advantages of multiple choice questions:

A1 They do not demand so much time and irrelevant writing from the student as conventional open-ended questions

A2 The answers are considerably easier to correct

A3 They offer a greater opportunity to make a fair assessment of the students' knowledge

The following general disadvantages have been assumed to exist:

D1 It is possible to arrive at the correct answer by guessing

D2 MC questions do not measure "real" knowledge – the active capacity to recall the right answer – but only the passive recognition of the right answer

D3 By means of MC questions you can only test knowledge at a low taxonomical level, knowledge of details

D4 MC questions direct the students to concentrate on details

D5 MC questions provide no training in writing

D6 MC questions may condition wrong responses, thus creating mislearning

D7 MC questions are inappropriate when you want to know how the student attacks a problem

D8 MC questions allow only a simple assessment without nuances – right or wrong

D9 Students like open-ended questions better.

These supposed disadvantages have been analyzed, e.g., in works by EBEL (1965, 1969a), MARTON (1967), EKLUND (1968), COFFMAN (1969), and LEVIN & MARTON (1971). None of the arguments appears to be valid as revealing a general deficiency in multiple choice questions. For instance, it has been demonstrated (e.g., by BLOOM, HASTINGS & MADAUS, 1971; MILLER & WILLIAMS, 1973) that it is possible to design MC questions at practically all taxonomical levels, thus aiming at practically all kinds of cognitive objectives (cf. D3).

As a rule, the correlation between results on MC tests and results on corresponding tests consisting of open-ended questions is very high (cf. D2).

The risk of conditioning wrong responses (D6) is relevant only if the content covered by the MC questions is completely new to the student, not if he has studied it before taking the test (EKLUND, 1968).

It is quite possible to weight different "wrong" alternatives, distractors (D8). However, this appears not to improve the measurement properties of the test (WEDMAN, 1973).

The assumed disadvantages D1, D4, D7, and D9 seem mainly to depend on how well constructed the MC questions are. Probably, the negative attitude to MC questions which is sometimes found, depends on previous experience of poorly designed MC tests.

As to argument D5, it is undisputably true that MC questions do not provide any training in writing. Thus, if a main learning objective of a course is that students should reach a certain level of proficiency in written communication, then MC questions are, naturally, not particularly suitable in this course, neither as a training device nor as an evaluation aid. In other courses, essay questions might mean an unnecessary wastage of the student's time (cf. A1):

> Students spend most of their time in thinking and writing when taking an essay test. They spend most of their time in reading and thinking when taking an objective test. (EBEL, 1965, p. 90)

Reading is normally a considerable quicker task than writing. Consequently, students get more time for thinking when taking an MC test. (Alternatively, they save time for other activities.)

Thus, researchers who have penetrated the problem seem to agree that multiple choice questions have certain advantages over essay questions, that their possible disadvantages can be neutralized, and that they can be designed to measure the attainment of most kinds of those educational objectives which can be measured by means of other types of questions. In many cases, however, it might be a difficult task to design good MC questions for higher level objectives. Therefore, we must consider in which phase we want to concentrate the heaviest part of the work: in the constructing phase where the questions are worked out, or in the evaluation phase where the answers are corrected and commented upon.

Traditionally, assignments in correspondence education have largely been of essay type. Nevertheless, multiple choice questions seem to have been used to a considerable extent for several years in USA (ESTABROOKE, 1950; KEMPFER, 1965).

In Europe, however, a majority of the correspondence schools which are members of the two organizations EHSC or CEC appear to adopt a hesitant or negative attitude to MC questions used as assignments for submission (BÅÅTH, 1976). Questions of this kind are not considered congruent with certain instructional objectives or educational goals, and/or they are not regarded as good promotors of two-way communication with feedback and personal dialogue.

The power of tradition, coupled to scepticism towards a phenomenon with which, probably, many of the schools are hardly acquainted, might provide an explanation of this attitude among European correspondence educators. The second most important reason probably is difficulty: As stated above, designing good MC questions demands not only subject knowledge but also educational insight, creativity – and time. The influence of the official examination system is, undoubtedly, another constraint in certain countries.

It should be added that a dialogue may be induced by MC questions as well as by essay questions. The possibility of a fruitful dialogue depends on the quality of the assignments and on the degree of inspiration and thought used by the tutor in writing his comments. The specific kind of questions is not crucial.

THE PROJECT

As indicated above, the major aims of the CADE project was to improve some of the essential learning conditions of our correspondence students in at least certain courses, and, thereby, to design a prototype of computer-assisted distance education.

Those learning conditions which we had in mind concerned, primarily, the two-way communication part of the correspondence education system. Above all, we wanted to improve

1 the quality of the tutors' comments with respect to (a) feedback effectiveness, (b) motivational aspects

2 the turn-round time of students' solutions to assignments for submission.

In addition, we had an idea that (3) the quality of assignments for submission could perhaps be improved by the introduction of MC questions. We speculated that course writers/tutors and editors would have to work more thoroughly with such questions, for instance, in order to be able to write stimulating comments for the computerized comment letters.

The project has been carried out in three stages. Stages 1 and 2 were designed as prestudies to the computer-assisted instruction in stage 3.

The project – its background, aims and design – has been described in greater detail by BÅÅTH (1971 a, 1971 b), where the results from stage 1 have also been reported. The results from stage 2 have been reported in BÅÅTH (1973 a, 1973 b).

Stage 1

In the first stage, we simulated the main parts of the planned computer-assisted correspondence instruction, by means of a simple optical reader, an automatic typewriter, and the operator of this typewriter. During stage 1 the simulated computer-assisted instruction was tried out in an elementary course in psychology (Arbetsledningens psykologi).

The attitudes of the students were almost surprisingly positive. Nearly 82 % stated a preference for multiple choice questions of the type used in the psychology course. Only 26 % adopted a negative attitude to mechanical correction by means of an optical reader, in the sense that they would prefer manual correction to mechanical. Two-thirds of the students reacted positively to typed comments, while a mere 4.6% said they would prefer handwritten comments.

The students' retention of knowledge seemed to be quite satisfactory, too. The group which had received "long" comments (with fairly detailed explanations, not only references to pages in the course material) was slightly – but significantly – better than the "short" comment group. In both groups also the rate of study appeared to be rather good, but in this respect, too, the figures were in favour of the "long" comment group. Therefore we decided to use rather extensive explanations as preproduced tutor's comments in our computer-assisted home study system.

Stage 2

In the second stage MC questions, suitable for optical reading, and preproduced tutor's comments, intended for writing out on the automatic typewriter, were constructed for a new course in a quite different subject, Ellära från början (Basic Electricity and Magnetism). For this course a pretest was also constructed. This test was handled in the same way as the MC assignments for submission.

Stage 2 had two major aims: (1) to test the simulated computer-assisted instruction in a course different from that which was used in stage 1, and (2) to study the effects from and attitudes to a test of previous knowledge within the framework of the simulated computer-assisted home study system.

The investigation concerning the effects from and the attitudes to the pretest was carried out as a simple experiment. The students were randomly assigned into two groups. The experimental group was induced to take the test of previous knowledge, while the control group did not receive any pretest. No other factor was systematically varied in this experiment.

The attitudes to the pretest were decidedly favourable. In addition, by the end of the period of investigation the experimental group had got on farther in the course than had the control group. The difference was significant.

With respect to the attitudes to the simulated CAI system, the results from stage 2 were very similar to those from stage 1 – with one exception. In contrast to what was found in stage 1, a majority of the students in stage 2 stated they would prefer manual correction to mechanical. One quite probable reason for displeasure with the mechanical correction in stage 2 was that the optical reader (Datronics 500) did not work too well. Therefore, a more reliable optical reader (Datasaab OMR-5900) was chosen for stage 3.

The results from the two prestudies indicated, we thought, fairly unequivocally that we ought to proceed to the final stage, the design of the real – not simulated – computer-assisted distance education system.

Stage 3

Stage 3 of the project had several aims and, consequently, comprised various sub-studies:

1 Development and evaluation

1.1 Developing the CADE system, including systems work, programming, working out manual routines, etc.

1.2 Practical test of the system. Here, the aim was to test how the system and its routines worked in practice. In addition, a preliminary economic evaluation was undertaken.

1.3 Evaluation of the system with respect to students' attitudes.

2 Experimental study of the effects of letting the students know explicitly that they were taught with the assistance of a computer.

In all sub-studies where courses and students were investigated, (1.2, 1.3 and 2), the same courses and students were involved.

As concerns the experimental study, it may be recalled that during the first two stages the students adopted a very favourable attitude to both type of assignment questions and correction/comments. We could, however, not be completely certain that the students realized that they were taught by means of a computer (or, in stages 1 and 2, by means of a simulated computer). Would the attitudes prove to be equally favourable even if the students were explicitly told about the computer (which would have to be done if the system was to be used in a broader scale)? As is well known, abuse of computer-stored data has, during recent years, caused a considerable distrust of – at least – certain uses of computers.

By dividing students into two groups – one experimental group which was explicitly informed that they took part in a computer-assisted teaching, and one control group which did not obtain this information – we could see if these two groups were different in some respect. In other words: We wanted to know if attitudes to the study, study results or study rate were influenced by the knowledge that a computer analyzed and commented upon the students' assignment answers.

In the following chapters we will first describe the design of the system. Then we will report the evaluation of the system, and after that the experimental study.

THE SYSTEM

In order to avoid tiring those readers who have little or no knowledge of ADP with specific details of the design of the ADP-system, we have chosen to split the presentation into two parts. To understand the report it is not necessary to read the second part, but we recommend those who are interested in how some of the functions are carried out to read both sections.

The system from the user's point of view

By hiding most of the technical details – e.g. an optical scanner and a computer – in a "black box" (named ADP in Figure 1) it is possible to show the main functions of the system in a simple model:

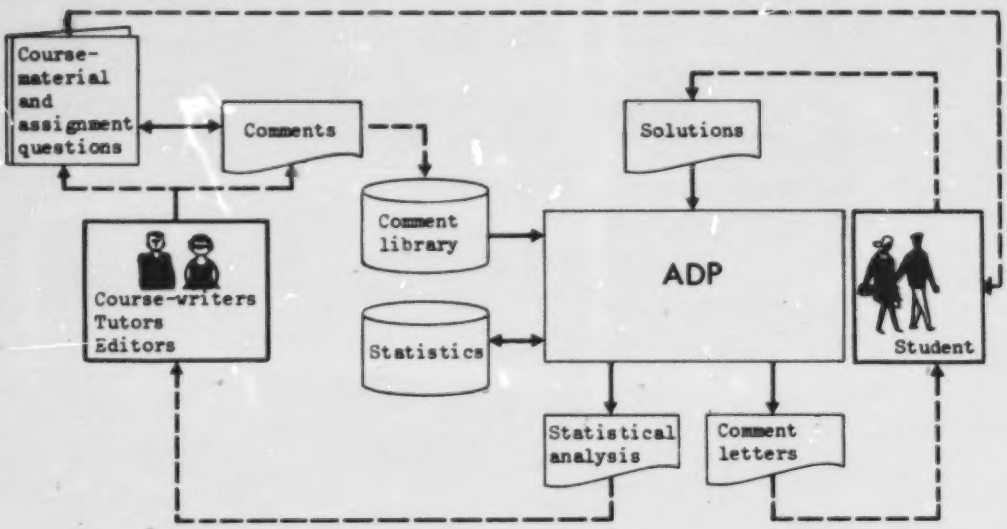

Figure 1. Hermods Computer-Assisted Distance Education System

To start with, let us see what the authors, editors and tutors are supposed to do and at the same time take a look at the parts of the system with which the student comes into contact.

The solutions

The solutions are designed to be read by an optical reader. This implies – at least with the present technique and financial conditions – that the assignments consist of multiple-choice questions. (Cf. the discussion concerning this type of question in the Background chapter.) The optical reader also requires a special type of answer blank form. See appendix 1, which shows a completed answer blank form.

Each set of blank forms consists of one original and one copy. The student keeps the copy. The upper part of the answer blank form is mainly used for identification. On application the student answer blank forms are provided with a computer pre-printed identification as to course, study unit and student. The identification is written out in full, but is also printed for the scanning machine to read. A maximum of 50 questions can be framed for each assignment in this version of the answer blank form.

The back of the solution form can be used by the student for questions or remarks that will be handled by the tutor, the editor or the counsellor.

The comment letters

The comment letter corresponds to the tutor's corrections and comments in ordinary correspondence education. We have considered that it is extremely important to make the comments as individualized, personal and stimulating as possible. We wish to make the student feel that there is, not only an able but also a generous person with a positive attitude behind the comments. The computer is merely a technical intermediary bringing about that person's message. We want the student to feel that the message is particularly directed to him.

Our intentions are already stated in the layout of the comment letter. A comment letter should look like an ordinary typed letter, and both upper-case and lower-case types are used (contrary to the earlier mentioned USAFI-system). See appendices 2-9.

But we have primarily concentrated on producing a system which allows the contents to be personal and stimulating.

A comment letter consists of five main parts:

1 Identification
2 Introduction
3 Comments
4 Evaluation
5 Concluding line.

Identification

The identification consists of the tutor's name, the student's number, name and address (the comment letters are mailed in window envelopes) and course number and name as well as number of assignment.

Introduction

The introductory texts are common to all courses. However, there are nine different texts for the computer to choose between, and this fact allows considerable variation. See the A-texts in appendices 2-7 and 9!

The introduction may be extended by a text referring to enclosed printed model answers, which are used mainly in subjects like mathematics, physics and technique.

See the B-texts in appendices 2-5 and 7!

If a student has made too many mistakes in an assignment, he or she gets another chance. Appendix 8 shows one of the three texts the computer can select in such cases.

Comments

The comments constitute the most interesting part of the letter, permitting considerable variations to be made. The following types of comments can be distinguished:

- Comments on individual questions

- Specific comments.

If a student has solved an assignment question incorrectly, he or she probably wants feedback containing the following information:

(a) a statement, telling the student that the solution was wrong

(b) information about the correct answer

(c) an explanation, if possible with a reference to the course material.

CADE satisfies these demands. Cf appendices 2-9!

Each comment on individual questions starts with a line containing question number, correct alternative and alternative chosen by the student. Varied standard phrases are used, e.g.: "You chose alternative x", or "Alternative x is your suggestion", etc. The following lines contain explanations, discussions and suggestions on what to repeat etc. These comments may be varied depending on which alternative the student has chosen. Cf., e.g., the comment made on question 1 in appendix 2 and appendix 3!

Both incorrect and correct solutions of single particular questions may be commented on in this way. Thus, it is possible to encourage a student who has successfully solved a difficult question. See appendix 9, questions 2 and 8.

Some subjects requires special types, e.g. phi, omega, roots and exponents. The system uses quite a lot of those as can be seen in appendix 3, question 11 and appendix 7.

In addition to this type of comment, the system makes it possible to use so called specific comments which can be of several different kinds:

- A specific comment referring to an entire study unit. (Example: Appendix 2 E.)

- A specific comment on a particular question or group of questions in current assignment with or without regard to the results of the questions. (Examples: Appendices 2 C, 3 C, 5 D and 6 B, where the comment is formulated taking into consideration the answer given by the student; appendices 5 C, 6 C and 7 C, where the comment is given regardless of the student's answer(s) to the question(s).)

- Furthermore, the system allows reference to earlier assignments. This means that the answer to a question or a group of questions in the current assignment combined with the answer to a question or group of questions in an earlier assignment directs the selection of comment. You will find two examples in the appendices: 5 D (where the second sentence runs: "Already in the first study unit you proved that you were able to solve all mobility problems, and some of them were difficult.") and 6 B ("In study unit 1 [question 12] we agreed on how important it is that, when interviewing a job applicant, the interviewee also gets an opportunity to ask questions. Similarly, when introducing and instructing newly-appointed persons, you should permit and even encourage questions. From your answers to questions 3 and 5 in this study unit you also seem to be fully aware of this – good!")

  Thus, there are numerous possibilities for personalizing this computer-mediated tuition. Nevertheless, out of economic considerations, we have accepted the following restrictions: (1) A maximum of 5 specific comments

can be written for each assignment. (2) No comment – of any kind – is allowed to exceed 10 lines. (However, if you need more lines, you may combine two specific comments, or one specific comment and one comment on a particular question – thus obtaining a maximum of 20 lines.)

Evaluation

In all comment letters, the computer writes out the student's number of correctly answered questions, and – if so wished – his grade. In addition, it prints a concluding comment on the student's achievement for a particular assignment. At present, the computer can choose between 39 different concluding comments. (The capacity of the system allows us to design even more comments of this kind. However, all the possibilities have not yet been utilized.)

You will find a few of the 39 varieties of concluding comments in the appendices. (See 2 D, 3 E, 4 C, 5 E, 6 D, 7 E and 9 B.)

According to our intentions, the most important purpose of the evaluation part is its function of stimulating motivation. Therefore, the concluding comment is – as far as possible – worded in a friendly way: encouraging, supporting, praising etc.

If a student achieves better than on the previous study unit, this is pointed out in the concluding comment. (See 3 D: "Very good – and better than last time!"

In a corresponding way, a deterioration in the student's achievement standard is pointed out. (See 6 D: "You seem to be able to achieve even better results, but on the whole you have attained the goal of this study unit. As you see ...")

When the student has finished his course, the computer writes out a particular final comment (see 9 C), as well as an (optional) final grade.

Concluding line

The comment letter is concluded by "Kind regards" and the tutor's (the subject specialist's) signature.

Comment library

In order that the computer should be able to compile the comment letters, every particular comment must have been written in advance and stored in a form which is accessible to the computer.

In the ideal case, the course writer (if necessary – and possible – in collaboration with the editor or/and an educational expert) prepares the comments to the assignments for submission at the same time as he designs the course material and the assignments. The advantage of this procedure is that the person who writes the comments is forced to closely examine the assignment questions and to look at them from the students' point of view. Thereby errors, obscurities etc. – if any – may be discovered at an early stage.

When the comments are prepared, they are punched on to cards to be forwarded to the disc memory of the computer. This disc memory stores every comment to all the different courses in the system. From these comments – which compose the comment library – the computer picks the building-bricks to the comment letters.

However, some further pieces of information are needed in order that the system can work, i.e., the "correction models" which specify criterions for selection of comments: correct answer alternatives, minimum number of correct answers for each grade level, etc. These pieces of information are also stored in the computer.

Thus, for each study unit, the computer has to be furnished with

- comments on individual questions,
- specific comments (if any), and
- correction models.

Introductory texts, concluding comments, grade texts, as well as some other standard texts are general. Consequently, they need not be written for each new study unit.

By the use of specific methods when searching for comments on the disc memory, the same comments on individual questions and specific comments can be used in different courses. Various versions of the same course, with partly different assignment questions, may also be used simultaneously.

Statistics

A very welcome by-product is what is called statistics in the figure. Relevant information is stored every time a solution is run through the system. This information can be analyzed and arranged in order to obtain a basis for the evaluation and revision of courses and system.

Development potential

A characteristic of the flexibility of the system is the possibility to mix conventional assignments (for manual tutoring) with assignments for computer-assisted tuition. This possibility is already utilized at NKS in Norway. A number of improvements are, however, possible and – more or less – desirable:

- For each study unit, questions 51-57 in the upper right part of the answer blank form "Studiesvar" may be used for answers to a mini-questionnaire. The aim of this questionnaire is to find out the students' attitudes to the study unit in question – or to the whole course. Brief comments should be given to the student's answers in the comment letter. If the student adopts a negative attitude, he may be asked to explain what he is not pleased about and what he thinks could be done to create better conditions.
- Differential marking of questions and alternatives. E.g., by weighting of alternatives, a mistake concerning a decimal may be given 0,5 points, while a more "serious" mistake would deserve 0 points.
- The possibility of allowing two or more answer alternatives to each question to be correct. (In the present version of the system only one alternative to each question is correct.)

ADP aspects of the system

In the previous section the function of the system was briefly described with a certain emphasis placed on the output – the comment letters – and the manual routines. In this section however we shall see what is inside the rectangle named ADP in figure 1.

Configuration

The answer blank forms are designed to be read by an optical reader – OMR-5900 (Studiagnos). The optical reader is connected to a paper tape punch (Facit 4070).

For the punching of comments and what we call correction models which specify the criterious for selection of comments, correct alternatives, operator's code etc) ordinary card punches (IBM 029 and 129) are used.

The computer used during the development of the system is an IBM 370/145 with a storage capacity of 512 K. However, considerably smaller computers may be used.

The peripheral equipment used in the system are

- card reader (2501)
- paper tape reader (2671)
- printer (1403)
- 4 tape units (3420)
- disc drive (3330)

System flowchart and programs

On every processing occasion (periodicity at present twice a week) five programs (sortings excluded) are active – see appendix 10 a–c. One of these programs is written in Assembler Language while the others are written in COBOL. However, every program contains Assembler modules.

In the following I will refer to the flowchart in appendix 10.

Program 1 reads the punched paper tape (containing the students' answers) and converts the information into edited transactions stored on magnetic tape. The input is controlled with reference to formal errors and a list of signals is produced.

Program 2 is reading and controlling punched cards. Several types of cards are included and all except one are used for creation and changing of the register of correction models (RCM). The remaining card type is used for deletion of solutions previously registered in the system (see Previous solutions, program 4).

The control of the formal correctness of the card transactions is very thorough and here too, a list of signals is printed.

Sorting 1 sorts and combines the records from files 1 and 2. The sequence and sorting keys (course number and study unit number) are identical to those of the RCM.

Program 3 has two main tasks:

- Updating the RCM
- "correcting" student answers.

The correction includes the following operations:

- Matching the solution and the correction model
- computing the number of correct answers
- completing the records from file 1 with information from the RCM.

The result of these operations is file 3, which together with the updated RCM, transactions for statistical analysis and a list of signals constitute the output of the program.

In Sorting 2 the solutions are reorganized, and sorted in the same order as the previously registered solutions, i.e. sorted on student number, course number and study unit number in ascending order.

Program 4 is the actual main program, and it takes care of the analysis of the solutions, the connection between current and previous solutions, selection of comments, evaluation of results, etc. Space does not permit a detailed description or the program. We will therefore just say a few words about the comment library: The comments are stored on a disc memory and the organization is indexed sequentially. Every single line in a comment corresponds to a record in the comment library. In order to achieve sufficiently rapid access a special search method is used:

The first line in every comment is searched randomly. When line number one is found the remaining lines are read in sequence until the program finds an interruption code in the last line of the comment.

By transaction file 5 the CADE-system is connected with another computer system. This so called "Student routine" is an administrative system handling information concerning student identification, study planning, study results, payments, etc. Thus, some of the transactions in file 5 provides the student register with information, e.g. grades and final grades, while other transactions order names and addresses (file 6) for the comment letters. One type of transaction initiates printing of single answer blank forms for students who are recommended to try again.

Program 5, finally, reads transaction files 4 (comments) and 6 (name and address). When the comment letters are compiled they are printed by means of a special type chain containing upper-case and lower-case letters, figures and several special types.

Service routines

In addition to the programs described in the preceding section the system is completed by a number of service programs, e.g. programs for creation of comment library (see appendix 10 d) and tutor file, printing of correction models, etc. However, in this context they are of comparatively little interest and do therefore not require any further discussion.

THE INVESTIGATION: METHODS AND PROCEDURE

Methods

The evaluation of the system

During the whole test period, all parts of the system were carefully supervised. Faults and imperfections have been remedied as far as possible. The practical experience thus obtained has been evaluated and is reported in a separate section of the next chapter.

In another section of the same chapter a simple economic evaluation is attempted.

In addition, data on the students' attitudes were collected by means of a questionnaire, which contained questions about

- the assignments for submission (i.e., the multiple choice questions)
- the answer blank
- the comment letters
- the turn-round time
- the instructional system as a whole.

Within the framework of this investigation it has not been possible experimentally to compare attitudes and results etc. of students taught by means of CADE with attitudes, results etc. of other, traditionally taught correspondence students. (A study of this kind is, however, undertaken within the EHSC research project "Two-way communication in correspondence education"; cf. p. 35 in this report.)

The experimental part of the investigation

Nevertheless, one part of the CADE investigation was experimentally designed. When enrolling, all students included in the evaluation of the system were distributed at random between an experimental group and a control group. The members of the experimental group were informed that, in their courses, a computer-assisted tuition system had been introduced. The members of the control group obtained no such information.

By this experimental design we hoped to get answers to the following questions:

Is/Are the students'

- completion of her/his study,
- study rate,
- grades on assignments for submission, and/or
- attitudes (as measured by means of a questionnaire)

influenced by the knowledge that they are taking part in a computer-assisted correspondence course?

Courses

Certain demands had to be made on those courses which could be used for the investigation:

1 A fairly large annual number of participants

2 A comparatively short average time required for studying the course

3 The objectives and the contents of the course reasonably well suited to assignments of a multiple choice type.

In addition, we looked for courses, varying with respect to a) length (average study time required), b) type of subject.

Four courses were selected which, as far as possible, corresponded to the demands made:

ADP for Everyone ("ADB för alla") is a very short introductory course. It is usable in the upper secondary school subjects ADP and business economics, but is also suitable for employees who need some, but not too thorough a knowledge of ADP. The course material consists of one booklet with about 80 pages and one submission of assignments.

Psychology of Management ("Arbetsledningens psykologi") is an elementary course for supervisors, foremen etc in industry as well as for office managers etc. It aims at providing insights, which could be useful in practice. The course material includes four basic booklets + one booklet for revision and summary by means of cases, in total, approximately 160 pages. This course has four submissions of assignments. (The Psychology of Management course was utilized also in the investigation of stage 1.)

Basic Electricity and Magnetism ("Ellära från början") is a fairly comprehensive course adapted to the upper secondary school curriculum but used also in vocational training programs. The course material includes about 450 pages: textbook + workbook + (a short) study guide. This course has nine submissions of assignments. In addition, there is a pretest. (Basic Electricity and Magnetism was used also in the investigation of stage 2.)

Basics of Electrical Engineering ("Elteknikens grunder") is intended for those who wish a short survey of electricity, e.g. an introduction to the study of a number of specific technical subjects. The course material includes a textbook and a short study guide, in all around 125 pages. There are three submissions of assignments.

Experimental groups

From 3/9 1973 to 15/2 1974 all students applying for any of the four courses selected were divided at random into an experimental group and a control group, according to the last digit (odd - even) in their application number. By February 15, 1974, the experimental group included 317 students, and the control group 369, i.e., 686 students in all.

Data collection

Data have been collected concerning the students'

- study rate and status at the end of the course,
- results on assignments for submission, and
- attitudes (according to their answers to the questionnaire).

The intake of data was completed by the end of 1974, i.e., sixteen months after the first students, and ten months and a half after the last students had been included in the experiment.

The questionnaire was sent to students who had completed their course, i.e., sent in answers to questions in all assignments. However, by the end of 1974 very few participants in the fairly comprehensive Basic Electricity and Magnetism had finished the course. Therefore, the questionnaire was also sent to those students on this course which had not completed it but had accomplished at least two assignments.

The students' distribution between courses, as well as the response frequencies is shown in table 1.

Table 1. Number of applications, questionnaires sent out and questionnaires returned, by course

	Applications	Questionnaires sent out f % of applications	Questionnaires returned f % of applications	% of qu. sent out
ADP for Everyone	89	53 59,6 %	51 57,3 %	96,2 %
Psychology for Management	282	180 63,8 %	174 61,7 %	96,7 %
Basic Electricity and Magnetism	182	76 41,8 %	69 37,9 %	90,8 %
Basics of Electrical Engineering	133	58 43,6 %	57 42,9 %	98,3 %
TOTAL	686	367 53,5 %	351 51,2 %	95,6 %

When the intake of data was stopped, 314 students had completed their courses. The questionnaire was also sent out to 53 participants in Basic Electricity and Magnetism which had not completed this course but had accomplished at least two assignments. Thus, the total number of questionnaires sent out was 367. The number of questionnaires returned – after two reminders – amounted to 351. This means that only

around 4 % of those students to whom the questionnaire was sent did not return it, an almost surprisingly low proportion.

However, the proportion of completers is not very high: just 46 % of the applicants. There are a number of reasons for this. Firstly, the proportion of nonstarts and dropouts in correspondence education – as in other forms of non-compulsory adult education – is generally fairly high (cf., e.g., REKKEDAL, 1972). Secondly, the experimental and control groups include a substantial number of students who had applied for longer courses, each comprising several single subject courses like those included in the experiment. On application, such students are sent study material for several single subject courses at the same time. The order of studying courses, for which material is sent at the same time, is optional. Therefore, some of the students taking part in the experiments may have postponed their study of the experiment course in favour of one or more of the other single subject courses obtained in the same parcel.

Finally: Almost half of the non-completers studied Basic Electricity and Magnetism. It is a rather comprehensive course (nine submissions), and many students appear to think it is comparatively difficult (BÅÅTH, 1973b), which may explain why the time required for completing this course is often considerably extended.

Statistical analysis of data

The dependent variable in the experimental part of the investigation is in most cases at an ordinal scale level. This fact suggests that Kruskal-Wallis' analysis of variance and Mann-Whitney's U test are appropriate methods for statistical analysis. However, the method we used is Chi-square, mainly for practical reasons. The IBM Survey Analysis Program (SAP) automatically provides the chi-square value and degrees of freedom for every contingency table if desired, which of course facilitates the computations even if we afterwards had to combine a number of cells.

The level of significance is 5 %, a choice that is motivated by the purpose of the investigation. Thus, a difference will be regarded as significant even if it is comparatively small.

RESULTS

Evaluation of the system

When discussing data processing it is a common mistake to believe that the system is equal to the computer system. An implemented, working system consists of several manual routines, blank forms, internal users, external individuals (in this case students) and, of course.the computer system. All these different components must be combined to form a functional unit. Thus, the practical experience of the functioning of the system is an important part of the evaluation. Further important aspects are the costs and the students opinions. In this section the practical experience of the system, questionnaire answers and an attempt to make an economical evaluation are presented.

Practical experience

It appears from the preceding section that the hardware equipment is rather extensive. Components of special interest are those at the beginning and at the end of the ADP-system, i.e. the optical reader and the type chain of the printer.

Printing of the comment letters – accomplished by means of the type chain mentioned above – has been made without any problems. It is almost impossible (except for a very well trained eye) to see any difference between a comment letter and an ordinary, typed letter. This is important as it was proved tiring to read "normal" computer printout (e.g. used in the previously mentioned USAFI-system).

The optical reading has also functioned well. At the start a characteristic of the optical reader caused certain problems. When an answer form (appendix 1) is fed into the optical reader the reader should be able to discriminate between "boxes" that are filled and those that are not. For a reader of this comparatively uncomplicated type there are only two possible results, i.e. "filled" or "empty". Technically more advanced readers have in addition another type of result which can be called "uncertain", meaning that it is not certain that the box in question can be classified as neither filled nor empty. In such cases the form has to be examined manually. However, the cost for an optical reader of the latter type was (at least in this stage of the project) too high, and the reader we chose was considered to be sufficiently good.

Thus, problems arise when a marking is very faint and the optical reader interpretation is "empty", or when the blank is dirty or soiled (depending on badly made erasures or e.g. dirty fingers) and the reader reacts as if the box is filled in. The problem was made worse by the fact that the markings made by the computer (for identification of student, course and study unit) contains a comparatively small amount of graphite (which is necessary for the optical reader to react properly). In other words, even if the computer markings are sufficiently black for the human eye, the optical reader may not react.

In order to decrease the number of reading errors we were forced to make a visual examination of the answer forms before they were fed into the optical reader and, if detected, the presumptive causes of the errors were corrected. By this action the number of reading errors were almost entirely eliminated.

The integration of ADP-routines and manual operations is a critical phase in every system that includes ADP components. The situation was in this case complicated by the connection with another sophisticated ADP-system. Thus, the environment in which the CADE-system was supposed to work was very complex. However, the

administrative system to which the CADE-system was connected had been used for rather a long time, and by using the experience gained during the first two phases, we managed to avoid serious problems during the implementation.

How the system has functioned from the user's point of view is a question which to a large extent will be discussed in the next section, which presents the students reaction. However, we will here concentrate on two other categories of users, i. e. the pedagogical staff and the administrative staff.

The pedagogical staff consisting of course writers and/or tutors and other educational experts were responsible for the multiple-choice questions.

We have already – in a previous section – pointed out the difficulty of making good multiple-choice questions. Not unexpectedly, writing instructive and motivating comments was also shown to be an exacting task. In both cases the persons in question have to be trained. The training – which must also include the other parts of the system – may of course consist merely of a conversation between the expert and the author/tutor. However a user's manual should be produced as well.

The tutor, responsible for a course, is involved in one further case, viz. when the students (often at the back of the answer form) asked about, or commented on, something in connection with their studies. The tutor could either reply separately or directly to the comment letter, and both methods worked very well.

The administrative staff, who took care of all of the handling of answer forms, comment letters and signals from the system, was subject to most of the minor problems that appeared in connection with the introduction of the system. However, after the elimination of these previously mentioned problems by means of the optical reader the administration on the whole functioned very well.

Answers to the questionnaire questions

We start with those questions which are related to the previous sub-chapter, that is, those concerning the working of the system in practice.

Administrative details

One might fear that a considerable proportion of the students would find it troublesome to fill in the answer form, since certain rules must be followed (choose the appropriate blank form, use a soft pencil, fill in the whole box, etc.). Therefore we asked: "Was it easy or difficult to fill in the blank form for optical reading?" The answers are shown in table 2.

Table 2. Answers to the question on filling in the answer form (See text!)

	f	%
Very easy	271	77,2
Rather easy	62	17,7
Neither easy nor difficult	15	4,3
Rather difficult	3	0,8
Very difficult	0	0,0
TOTAL	351	100,0

About 95 % stated that filling in the answer form very or rather easy, while barely 1 % found it rather difficult. Thus, it appears that the use of the particular blank form did not entail any serious problems for the students, at least not to those returning the questionnaire.

In another question, which was intended to test the reliability of the system, the students were asked if they had discovered any faults or inaccuracies in the comments to their assignment answers. Only three students answered this question in the affirmative. Two of these three students specified their statement. In one case it was a matter of misunderstanding, which was cleared up. In the other case, the optical reader occasionally had missed a few marks.

Turn-round time

The turn-round time – i.e. the time that elapses from when the student sends in his solutions until when she/he got it back – was, according to the students' answers 6 à 7 days, on an average (Md = 6,63 days). Practically all students who received their solutions within a week stated that they were content with the turn-round time. See table 3!

Table 3. Attitudes to turn-round time by reported turn-round time

Turn-round time (days) / Sufficiently prompt return?	3-4	5-6	7	> 7	TOTAL
	f %	f %	f %	f %	f %
Yes	50 100,0	102 96,2	116 95,9	46 67,6	314 91,0
No	0 0,0	4 3,8	5 4,1	22 32,4	31 9,0
TOTAL	50 100,0	106 100,0	121 100,0	68 100,0	345 100,0

The result from table 3 accords well with the finding of REKKEDAL (1973): When the turn-round time exceeds seven days, students may find this troublesome, but hardly when solutions are returned within a week. This result is also almost identical to what was found in stage 1 of this project (BÅÅTH, 1971b, p. 42).

However, in comparison with stage 1, the turn-round time in stage 3 was considerably longer (Md = 6,63 days compared to Md = 4,39 days). This increase is due to the fact that in stage 3, because of the expense, students' solutions were computer-processed only twice a week, while in stage 1 (and 2) comment letters were written out daily on the automatic typewriter. When more courses are transferred to the CADE system the periodicity of the computer processings can be changed to three or, perhaps, more times a week. This in turn will make it possible to reduce the turn-round time considerably.

The assignment questions of multiple choice type

Attitudes to the assignments for submission – which, without exception, were of multiple choice type – were very favourable. 81 % of the answering students found the assignment questions "very stimulating" or "rather stimulating". Only 1 % thought they were "rather dull". The remaining 18 % were indifferent ("neither stimulating nor dull").

This result is almost identical to what was found in stage 1, while the attitudes to the multiple choice questions in stage 2 were somewhat less favourable. The difference might depend on the students' perception of the level of difficulty of the questions (and, indirectly, of the various courses). In stage 2 the course Basic Electricity and Magnetism was used, which was judged to be rather difficult by the students; the same judgement was made of the assignments for submission. As mentioned, Basic Electricity and Magnetism was also used in stage 3. Here, the students found it the by far the most difficult of the four courses used. The same applies to the assignments for submission: They were considered to be the most difficult – and, in addition, the least stimulating.

The attitudes to multiple choice questions are also elucidated by the answers to the following questionnaire question: "Which type of assignment questions would you prefer if you were allowed to choose for yourself – 'ordinary' questions, to which you would formulate the answers yourself, or multiple choice questions of the type found in this course?" See table 4!

Table 4. Preference, type of assignment questions (I)

	f	%
I should certainly choose "ordinary" questions	5	1,4
I should probably choose "ordinary" questions	26	7,4
It would make no difference whether the questions were of the one type or the other	43	12,3
I should probably choose multiple choice questions	161	45,9
I should certainly choose multiple choice questions	112	31,9
No reply	4	1,1
TOTAL	351	100,0

Only about 9 % said they would prefer assignment questions of the conventional type, while nearly 78 % stated a preference for multiple choice questions. This – rather astonishing – result is also almost identical to what was found in stage 1 of the project.

However, the students were also asked about their choice if there had been a third option: both multiple choice questions and "ordinary" questions. (It is e.g. possible to have every second submission contain questions of "ordinary" type, while the remaining submissions have multiple choice questions). See table 5!

Table 5. Preference, type of assignment questions (II)

	f	%
Only "ordinary" questions	8	2,3
Both "ordinary" questions and multiple choice questions	205	58,4
Only multiple choice questions	137	39,0
No answer	1	0,3
TOTAL	351	100,0

Evidently, the most popular option was the combined one. At NKS in Norway this variant of the CADE system has already been tried, successfully.

Comment letters and model answers

In the two pre-study stages of the project, a qualified majority of the students said that they preferred typed comments to handwritten comments. The same result was obtained in the third stage, where the answers are distributed in nearly the same way as in stage 1 and 2. See table 6!

Table 6. Answer to the question: "If you were allowed to choose, would you rather have typed comments (as in this course) or handwritten comments?"

	f	%
I should certainly choose typed comments	141	40,2
I should probably choose typed comments	88	25,1
It would make no difference whichever type of comments I received	100	28,5
I should probably choose handwritten comments	16	4,5
I should certainly choose handwritten comments	6	1,7
TOTAL	351	100,0

About 88 % of the answering students found the comments just as extensive and detailed as they should be. Only 11 % would prefer more extensive and detailed comments.

Further, we asked the students about the instructional value of the comments. See table 7!

Table 7. Answers to the question: "Do you think that, thanks to the comments, you ... have understood how the assignment problems should be solved?"

	f	%
Yes, always	181	53,6
Yes, as a rule	133	39,3
Sometimes	22	6,5
No, as a rule not	1	0,3
No, never	1	0,3
TOTAL	338*)	100,0

*) Only those students who had made at least one mistake were supposed to answer this question.

Thus, nearly 93 % of the answering students thought that, thanks to the computerized comments, they had – always or as a rule – understood how the assignment problems should be solved, which means a fairly satisfactory proportion.

In stage 1 and 2, the attitude to the concluding comments was clearly favourable. This is, no doubt, true also as concerns stage 3. See table 8!

Table 8. Answers to the question: "The comment letters are concluded by some sort of evaluation comments. How did you feel about these comments?"

	f	%
I felt much encouraged or stimulated in my study work	125	35,6
I felt rather encouraged or stimulated in my study work	197	56,1
I did not notice any concluding evaluation comments	18	5,1
If anything, I was rather annoyed by them	5	1,4
I was very annoyed by them	1	0,3
No answer	5	1,4
TOTAL	351	99,9

It is interesting to note that no less than about 92 % said they were pleased with the concluding comments. One of these students added this spontaneous observation to his answer: "It is wonderful to know that you have got on well – and that you can do even better!" – Thus, it appears that the concluding comments serve their intended, motivational function.

In the two electricity courses pre-printed model answers to all assignment questions are provided, in addition to the computerized comment letters. One major reason is that, in mathematics as well as in scientific and tecnichal subjects, the student may sometimes realize – and choose – the right answer without having worked out his answer according to the ideal method. Another reason is that in stage 2 (using the Basic Electricity and Magnetism course) almost 75 % of the answering students said that they would like some sort of comment or model answers to all assignments for submission, whether the students' answers were wrong or correct.

Now we asked the students of all four courses in stage 3 if they thought it would have been sufficient to have only pre-printed model answers (+ information about number of correct answers and grade), i.e. no computer-processed comments at all. See table 9!

Table 9. Attitude to the combination of pre-printed model answers + (computer-produced) comment letters

If there are model answers, comment letters would be	f	%
completely unnecessary	2	0,6
rather unnecessary	10	2,8
rather valuable	155	44,2
very valuable	183	52,1
No answer	1	0,3
TOTAL	351	100,0

No difference between courses was obtained. Consequently, it seems fairly obvious that the combination of comment letters and model answers ought not to be changed.

Attitudes to the CADE system as a whole

No less than 342 of the 351 answering students stated that they would "certainly" (226) or "probably" (116) consider applying for other courses with correspondence

instruction of the same type as they had just had. This means that more than 97 % of the students were apparently not dissatisfied, which seems to be an encouraging proportion.

In addition, we asked which type of correspondence instruction they thought they would prefer – this (CADE) type or the more traditional one. See table 10!

Table 10. Preference, type of correspondence instruction

	f	%
Certainly this type	122	34,8
Probably this type	145	41,3
It would make no difference	55	15,7
Probably "ordinary" correspondence instruction	17	4,8
Certainly "ordinary" correspondence instruction	5	1,4
No answer	7	2,0
TOTAL	351	100,0

Thus, slightly more than three quarters of the answering students would actually prefer instruction by means of CADE to traditional correspondence courses. Only around 6 % stated that they would prefer the "ordinary" method of correspondence instruction.

In addition, a substantial proportion of the students appeared to be convinced that this new form of instruction is effective. Nearly 45 % thought that they had achieved better results with the new method than would have been the case with the traditional one. Only 5 % were of the opposite opinion.

Finally, it may be noted that 76 % of the answering students maintained that their interest in the subject had increased during the study, while only 3 % stated that it had diminished. This is a most encouraging finding, since it indicates that CADE is not only an effective and rapid method of instructing but also a method which may foster favourable attitudes to the area of knowledge studied. This might, in turn, further the development of life-long learners.

Economy

To make an evaluation of costs based only on the limited utilization of the system during the trial period is, of course, very difficult. To be sure, the costs referable to the computer processing can be estimated with comparatively great certainty, if one starts from the actual costs of various volumes of solutions during stage 3, and extrapolates to other volumes. Such an extrapolation was, in fact, made. It indicated that the computer costs per comment letter (not page!) would be about one Swedish crown (i.e., round 25 cents) – or less – when more courses were included. This estimation was confirmed during 1976, when the system was run in a somewhat larger scale.

The manual part of the system is, however, more complicated as far as costs are concerned. Some routines in conventional correspondence instruction disappear, while new tasks have to be introduced. The design of multiple choice questions demands more time and costs than the construction of "ordinary" assignment questions. The same applies to the writing of comments for the comment library, compared with the composition of the model answers with which the tutors are normally provided.

The following costs appear to be of importance:

- additional costs for the design of multiple choice questions and computer comments
- punching costs (the comments are transformed to a medium which the computer can read – the punched card)
- costs for answer forms and optical reading of the students' answers
- computer processing costs.

In order to make a comparison possible, costs referring to marking and commenting – and recording – "ordinary" assignment solutions must be computed.

In addition, attention should be paid to the following factors:

- the total volume of solutions per computer run
- the number of students per course (or, more exactly: the average number of solutions submitted per study unit and course)
- the number of assignment questions per study unit and course
- the estimated duration of the assignment questions.

The (additional) costs for design of multiple choice questions and computer comments and the costs for punching comments depend to a certain extent on the number of assignment questions and on the estimated duration of the assignment questions. In other respects, these costs may be regarded as fixed. Thus, the cost per solution will decrease, if the number of students on the course increases.

In contrast, the costs for the particular answer forms and for the optical reading of the students' answer marks on these blanks vary proportionally, i.e., the cost per solution is not dependent on the number of students in the course, nor on the total number of solutions.

The costs for computer processing are a decreasing function of the number of solutions, i.e. the cost per solution will decrease when the total volume of solutions increases. (Consequently, these costs are not course-dependent.)

During 1976, Hermods School had 8 courses in the CADE system with a total volume of 200 solutions per computer run, on an average (2 processing occasions a week). The number of students per course varies considerably, from around 1500 (in one course) to 200-500 applications a year. Each study unit in these CADE courses has an average of 15 assignment questions. The calculated duration of the assignment questions is 3 years. The design of multiple choice questions + computer comments is estimated to have required about 5 days' work per study unit. Our computer costs per hour are comparatively low: 700 Swedish crowns (≈ 170 US dollar).

Given these assumptions, we have calculated a cost per submitted solution which is equivalent to a tutor's fee of 3 or 4 Swedish crowns (around 70 cents to approx. 1 US dollar) – i.e. about the level of the average actual tutors' fees at Hermods School at present. This result must be regarded as satisfying, since

- the total volume is still comparatively small; when the volume is increased, the cost per solution will decrease
- the tutors' fees will certainly be continually raised, while computer costs will be unchanged or even decline.

In addition, it should be pointed out that it was not an aim of the project to attain a cheaper type of correspondence instruction. Nevertheless, it is of course desirable that CADE does not appear to be more expensive than conventional correspondence instruction, but is instead – in the long run – cost-reducing.

The experiment

The aim of the experimental part of the investigation was to find out if informing students explicitly about the computer-assisted instruction would effect the completion of their studies, their study rate, achievement, and attitudes to significant aspects of their studies.

Completion and study rate

By the end of the intake of data, about 54 % of the students had not (yet?) completed their studies. The discontinuations (or, in some cases, delays) appear to have affected the experimental group (E) and the control group (C) to the same extent. See table 11!

Table 11. The students' status by the end of the intake of data

Group / Status	E	C	TOTAL
	f %	f %	f %
Completion	148 46,8	166 45	314 45,8
Discontinuation	169 53,3	203 55	372 54,2
TOTAL	317 100,0	369 100,0	686 100,0

As is evident from the table, a somewhat higher proportion of E students completed their courses during the time of the investigation than was the case in the C group. The difference is, however, statistically insignificant ($\chi^2 = 0{,}21$; df = 1).

The same result was obtained as concerns study rate. No difference between the students of the experimental group – who were informed that they were taking part in a computer-assisted correspondence course – and the students of the control group was found.

Achievement

The grades of the students of the two groups have also been compared. For this purpose, each student's average grade on his assignments for submission was used. (5 is the highest grade, 1 the lowest.) See table 12!

Table 12. Grades by groups

Group / Grade	E		K		TOTAL	
	f	%	f	%	f	%
1	0	0,0	1	0,6	1	0,3
2	5	3,5	5	3,2	10	3,3
3	42	29,2	29	18,2	71	23,4
4	68	47,2	80	50,3	148	48,8
5	29	20,1	44	27,7	73	24,1
TOTAL	144	100,0	159	100,0	303	99,9

The groups' averages – 3,84 as concerns the experimental group and 4,01 with reference to the control group – display a difference in favour of the control group. However, this difference is within the boundaries of random variation. A χ^2 analysis (after merging of the cells of grades 1 and 2) yields the following results:

$\chi^2 = 5,70$; df = 3 – thus, no significant difference.

Attitudes

An analysis of the students' attitudes indicates rather clearly that there is no difference between the experiment group and the control group. Not until the tables were broken down by means of background variables (course, sex, previous experience of correspondence study, previous experience of multiple choice questions with correction by means of an optical reader, and study form – alone or in group) was it possible to find a few (4, in all) statistically significant differences between E group and C group. It was hardly possible to interpret the difference in more than one of these cases. Those members of the experiment group who had studied alone found the study more difficult than comparable members of the control group. (The possible explanation would be that if you study on your own and know that there is "only" a computer, not a living tutor, at hand, then you might feel your study task more difficult than if you dc not know how the tutoring is arranged.)

However, since a great number of significance tests were performed – nearly 100 – it is highly probable that the four significant differences found have resulted from mere chance. (At the 5 % level of significance we can expect chance significant differences in 5 cases out of 100. This phenomenon is known as "mass significance".)

The outcome of the experiment as a whole

The experimental variable appears to have had no effect on either completion, study rate and achievement, or attitudes to the study.

One possible explanation of the lack of effect of the experimental variable is, of course, that members of the control group also understood that their answers were, in some way, handled and analyzed by a machine. The answer form might have contributed to such an understanding. Another possible explanation is that the members of the experiment group did not read the information sheet as carefully as was intended. Both cases tend to equalize E and C groups.

However, yet another possible explanation is that we have obtained an almost unambiguous answer to the question that we asked when designing the experiment. There is a lot of evidence to indicate that, as far as the CADE system is concerned, it does not matter whether the students know that the tutoring is carried out by means of a computer or not.

DISCUSSION

Possible sources of error

How representative are the courses utilized in the investigation?

We chose courses in three different subjects, on somewhat various levels, of varying extent, and with student groups that were probably not equivalent. Are they representative of the courses and students of Hermods School? Are they representative of correspondence courses and correspondence students on the whole?

To the first of these two questions we think we can answer yes: The four courses are reasonably representative of those Hermods School courses where it would be possible to use assignment questions of a multiple choice type. Certain complementary information will be provided by the ongoing EHSC research project "Two-way communication in correspondence education" (BÅÅTH, 1974b; FLINCK, 1975), where among other CADE courses, one in elementary English is utilized. Thereby a possible gap is filled up regarding the representative nature of the courses.

Besides, in the EHSC project a direct comparison between tutoring by means of CADE and traditional correspondence tutoring is made. In the elementary English course and an upper secondary school course in psychology, some student groups studied by the conventional correspondence method while some other groups used the CADE system. The preliminary results indicate that continuation and completion are better in the CADE groups, and that there is no difference between traditionally tutored students and CADE students with respect to achievement.

The second question – about how representative the courses (and students) are on the whole – is, of course, much more difficult to answer. Probably they are fairly typical of the mainstream of correspondence education. However, practices vary among correspondence teaching institutions, and some correspondence schools recruit their students from rather specific groups with particular study goals. Therefore, every reader who represents a correspondence teaching institution had best try to judge for herself/himself the applicability of our findings to her/his institution.

To what extent did the dropout affect the results?

The major part of the students to whom the questionnaire was sent were completers. Do we know anything about the remaining over 50 % of the students who had not sent in solutions to all assignments and, consequently, did not obtain the questionnaire? It might be hypothesized that these students were more negative to CADE than the completers.

In order to obtain some information with reference to this question we made a special analysis of those Basic Electricity and Magnetism students to whom the questionnaire was sent although they had not completed their course (cf. p. 22). It appeared that these students were (at least) as positive as the completers of the same course to the multiple choice questions, the computer-typed comments, the evaluation comments – and the system as a whole.

We might have obtained similar results if we had had the possibility to analyze non-completers of the remaining three courses in the same way. However, we cannot be sure of that.

Another two remarks

Multiple choice questions are differently well fitted for various courses

The goals and objectives of a course, among other things, determine how useful multiple choice questions are. An exclusive use of multiple choice questions in, e.g., language courses over the beginner's level would probably not be recommendable. Moreover, the majority of the answering students thought that a combination of multiple choice questions and "ordinary" questions would be ideal.

The system demands whole-hearted efforts from the "tutorial programmers"

Assignments for submission and comments must be most carefully designed. The preparation demands subject knowledge, linguistic mastery, pedagogical insight, imagination, empathy and a positive attitude to students – but also patience and accuracy. In other words: Exactly those traits characteristic of an ideal correspondence tutor!

In addition, a correspondence course writer/tutor who has no previous experience of the system, needs special training before good multiple choice questions and computer comments begin to flow from her/his pen.

How could the very favourable attitude of the students be explained?

Some of the success of the CADE system may be due to the type of assignment questions. Probably the multiple choice questions save a good deal of the students' time – time which would otherwise be used on tiring and sometimes rather irrelevant writing. This might have contributed to the students' favourable attitudes, not only towards the assignment questions but also towards other components of the system – and towards the system as a whole.

Nevertheless, other factors have also been in operation. The turn-round time is comparably short. (However, it can be made even shorter, as soon as a higher number of computer runs per week becomes economically justifiable.)

Probably, certain characteristics of the comments also contributed to the students' attitudes:

1 They are always legible (in contrast to certain handwritten comments)

2 They are comparatively detailed. – According to HARRIS (1975), a majority of a broad sample of British correspondence tutors meant that comments totalling 20-50 words per student assignment (= per submission) – or even less – would be sufficient. The average number of words per comment letter in CADE is about 300 (cf. appendices 2-9).

3 The tone of the comment letters, which we have tried to keep friendly, patient, encouraging – the computer never gets tired, irritated or angry.

The concluding comments of the comment letters – the evaluation comments – appear to play a certain motivational role. Some cognitivistic theorists (e. g., BRUNER, 1971) claim that the will to learn is an inner drive. Curiosity and the need to achieve competence are the driving forces of this will to learn. It is maintained by the individual's attainment of a certain degree of competence; as a con-

sequence the interest to continue learning increases. This cognitivistic view of learning reduces the importance of reinforcement by means of external stimuli, which, according to Skinner and other behaviorists play a primary role. Without exaggerating the importance of reinforcers like praise and positive criticism, we think we are justified in maintaining that, for many students, this kinds of encouragement may strengthen their motivation and even keep it at a level not too far from the initial one. Therefore, the concluding evaluation comments should be retained and, of course, be carefully designed.

The information to the students about the system

The outcome of the experimental study appears to allow us considerable freedom as concerns the information to the students. Probably, the best way to choose is to give the students all the information about the system that is required in order that communication between students and school will function as smoothly as possible.

Fields of application

It would seem possible to use CADE in all correspondence courses where multiple choice questions can be employed.

In this context it should be pointed out that multiple choice questions – and, consequently, CADE correspondence courses – may be of particular use to older students. In a number of investigations, adults of various ages were given memory tasks requiring (a) recognition (as in multiple choice questions), (b) recall. In all investigations, substantial differences between younger and older subjects were found on the free recall tasks, while no difference or a considerably smaller difference appeared on the recognition tasks. For results from one of these investigations, see figure 2!

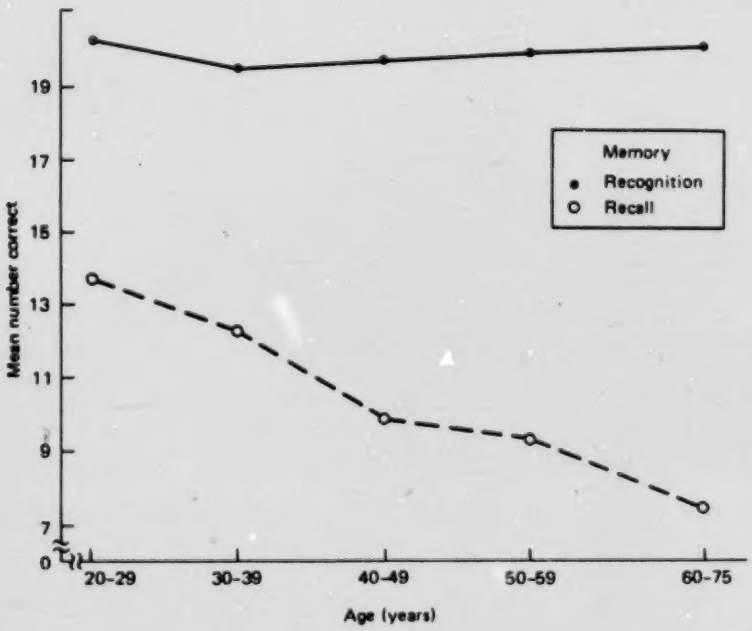

Figure 2. Mean recall and recognition scores as a function of age. (From WALSH, 1975. The investigation was carried out by Schonfield & Robertson)

However, although the CADE system can be applied to all courses where the goals and objectives permit multiple choice questions, we think that it may be of particular value in "campaign projects", i.e., courses which, during a short time, collect great numbers of students. If a correspondence school obtains 10.000, or "only" 1000, students in one course at the same (or almost the same) time, it probably meets considerable difficulties in arranging a correspondence course with traditional tutoring. By means of CADE it is possible, in such a case, to give every student correspondence tutoring of high quality without any delay.

Of course, the CADE system may equally well be also used within a wider distance education context, e.g., as a complement to radio or television teaching. Sometimes integrated radio/television and correspondence courses are designed. It seems reasonable to assume that CADE would be a most suitable component in such cases.

Finally, it should be mentioned that the CADE system might be utilized not only in distance education contexts but also in all teaching and learning situations where individualization of cognitive training and feedback is required or desirable. This applies to many training programmes in companies and organizations and even to official school systems.

Development potential

Adaption to a form of programmed teaching which furthers creativity

PETERS (1971, 1973) has described correspondence education as an industrialized process, characterized – among other things – by rationalization, mechanization and automation, mass production, and division of labour. As far as this description is adequate, it appears logical to proceed one step further and automatize those tutor functions which are repetitive and, consequently can be handed over to a computer (EHIN, 1973).

Moreover, the imminent risk of alienation on the part of the tutors, which PETERS (1973) points to, can probably be eliminated. When the computer has taken over all repetitive tasks in a substantial number of courses (or parts of courses), the creative and social tasks are left to the tutors: to design computer comments, and to involve in personal communication induced by questions or comments from the students – in addition to the traditional tutoring in the remaining courses (or parts of courses).

The industrialized process, which correspondence education – and, to an even higher degree, CADE – represents, appears to imply an instructional approach which is rather closely related to educational technology, or systems approach (PETERS, 1973). It would be possible to view CADE as a particular form of programmed instruction. It is questionable to what extent CADE allows the students to find an outlet for their creativity.

However, there is one form of programmed teaching which – according to its advocates – gives the creativity of students a real chance (EGAN, 1972, 1974; BÅÅTH, 1974a). The method is called "structural communication". Its main characteristic is that the student is invited to compose her/his answers by means of a "response matrix", which contains all important concepts, principles etc. from the actual study unit, in a compressed form. Several different answers to the same question may be correct, or more or less correct. The answers are discussed from various aspects. In figure 3 an example of questions and response matrix in a structural communication study unit is shown.

INVESTIGATION

Problem 1
A given amount of nutritious material can be obtained in one of two ways:

(i) Consuming a large quantity of food with low nutritional value and extracting the nutritious part.
(ii) Consuming food with high nutritional value, in which case little bulk is needed.

The second method is more frequently employed by the higher animals. Which items of the Response Matrix indicate factors that help such an animal to obtain the most nutritious food for itself from its environment?

Problem 2
It is not adequate for efficient nutrition merely to ensure that the food which is eaten is pleasant in taste and appearance, has a high nutritive value, and can be taken into the organism. Another important factor is to what extent the nutritive value of the food can be made available to the organism which eats it, and to what extent nutritive material passes through the gut and is lost in excretion. Remember, this loss refers only to the individual and not to the cycle as a whole. In fact it may well provide nutrition for some other organism. Select from the Response Matrix those factors which enable the organism to derive maximum benefit from the food as it passes through the gut.

Problem 3
The utilization of the food material by the body is of prime importance and is, in a certain sense, the key to efficiency. What factors do you consider to be important in the economy of the release of energy and materials from the food molecules, once they have been absorbed from the gut and incorporated into the organism?

Problem 4
How does the effective utilization of energy from the food make for more versatile day to day functioning of the organism? Apart from the energy requirements during growth, and for the maintenance and repair or replacement of old tissues, there are certain ways in which energy is consumed which are to the ultimate benefit of the organism as a whole. Which items of the Response Matrix do you think come under this category?

RESPONSE MATRIX

coordinated muscular system 1	mucus or cilia 2	technique for storing food and energy 3	ability to select diet 4
excretory system 5	division of gut into specialized functional regions 6	heart and circulatory system 7	gut microfauna and flora 8
parasitism as a way of life 9	temperature control 10	nervous system and hormones 11	osmotic control 12
senses— sight, smell, taste, etc. 13	division of labour between internal organs of the body 14	periodic feeding 15	increased body size 16
skeletal tissues 17	heterotrophism as a way of life 18	correlation of enzyme type with dietary input 19	lungs or gills 20

Figure 3. Structural communication: questions and the response matrix for these questions. The students composes her/his answers from the response matrix, by choosing one or combining two or several items from the matrix for each question. (From EGAN, 1974)

To adapt the CADE system to structural communication would mean a most interesting further development – fairly radical, but by no means impossible.

Connection to an on-line system

Of course, in our vision of the future of distance education we see the student who, by means of the telephone network or a public data network, gets in direct contact with a central computer, indicates her/his answers and receives immediate feedback, e.g., on his television screen. Up to now, only economy – national as well as private – impedes such a development. The technical resources have existed for several years.

SUMMARY

The aim of the project Computer-Assisted Distance Education was to develop a computer-assisted correspondence tutoring off line. The development work was carried out in three stages. The final outcome is a system where correspondence students' solutions to assignments for submission are corrected by an optical reader. The results are analyzed by a computer, which types out individualized comment letters to the students.

The system may well be also used within a wider distance education context, e.g., as a complement to radio and television courses. On the whole, the system might be applied in all teaching and learning situations where individualization of cognitive training and feedback is required or desirable.

In the first two stages of the development work (BÅÅTH, 1971, 1973), some of the functions of the computer were simulated by an operator at an automatic typewriter. In stage 3, the computer has been utilized on a full scale.

The specific aims of stage 3 were to develop and to evaluate the computer-assisted distance tutoring system, as well as to study experimentally the effects of explicitly informing part of the students about the role of the computer in the teaching system.

Evaluation

Practical experience

Practical experience has been in the main very positive. Some initial problems have been eliminated, while certain adjustments still remain to be made to the routines and development of programs for statistical analysis.

Answers to the questionnaire questions

686 students in 4 different courses were involved in evaluation and experiment. During the period of investigation, 314 students completed their courses. Answers were obtained from 307 of these completers, as well as from 46 of 53 non-completers to whom an almost identical questionnaire was sent. As concerns answers to the questionnaire questions, no difference between completers and non-completers was found.

The answer distributions are similar – sometimes almost identical – to the distributions obtained in the two prestudy stages of the project, particularly stage 1, i.e., a clear majority of the students adopts a favourable attitude to the system.

The answer form required for optical reading appears to have caused practically no problems.

As concerns the total turn-round time (Md = 6,63 days from the student sent his solutions till she/he got it back), 91 % thought it was sufficiently short. Almost all the dissatisfied students had had to wait for more than a week for their solutions.

The attitudes to the multiple choice questions were clearly favourable. 81 % found them stimulating. When asked to choose between multiple choice questions and traditional questions, nearly 78 % said they preferred the multiple choice type, while only round 9 % wanted the traditional type. However, if – in addition to

these two alternatives – there also existed a possibility to choose both types, 58 % stated they would prefer this combination, while 39 % thought that only multiple choice questions would still be best.

Handwritten comments seem not to be very popular among the students in this investigation. Only 6 % said they preferred this type of comment, while 65 % stated a preference for typed comments, like those in the CADE system.

The individualized computer-typed feedback comments appear to have worked well. They were judged to be just as extensive and detailed as they should be. In addition, 93 % thought that they had, thanks to the comments, always or as a rule understood how the assignment problems should be solved, while only about half a percent considered they had had no use of the comments.

The individualized computer-typed evaluation comments, which conclude each comment letter, were also very favourable received. Nearly 92 % stated that they had felt encouraged by these comments.

In two of the four courses, printed model answers to all submission questions were attached to each comment letter. More than 96 % of the students thought that the individualized comment letters were valuable even if they got model answers to all questions.

More than 97 % said they could imagine studying other courses with this new type of correspondence tutoring. No less than 76 % said they preferred the CADE type, while only slightly more than 6 % stated a preference for traditional correspondence tutoring. No difference was found between students who had previous experience of traditional correspondence courses and other students.

Economy

The evaluation of costs indicates that the CADE system is economically justifiable even with a fairly low volume of student solutions. If the system includes courses with thousands of participants a year, tutoring costs may be reduced considerably.

The experiment

The outcome of the experimental part of the investigation is fairly unambiguous. The fact that the members of the experimental group were explicitly informed about the computer assistance seems to have had no effect on either completion, study rate and achievement, or attitudes to the study.

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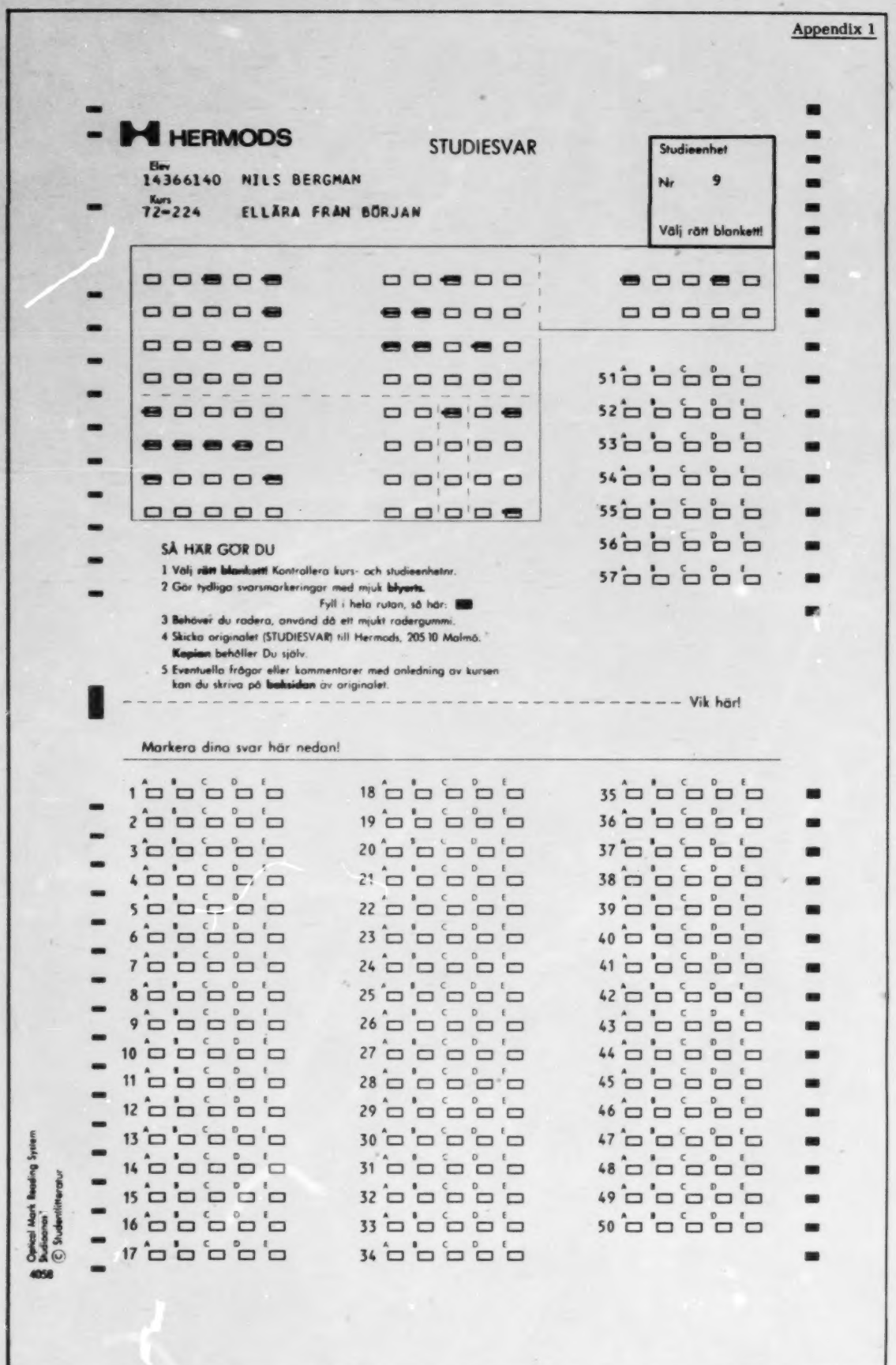

HERMODS

STUDIESVAR

Elev
14366140 NILS BERGMAN

Kurs
72-224 ELLÄRA FRÅN BÖRJAN

Studieenhet
Nr 9
Välj rätt blankett!

51 52 53 54 55 56 57

SÅ HÄR GÖR DU

1 Välj **rätt blankett!** Kontrollera kurs- och studieenhetnr.
2 Gör tydliga svarsmarkeringar med mjuk **blyerts.**
Fyll i hela rutan, så här:
3 Behöver du radera, använd då ett mjukt radergummi.
4 Skicka originalet (STUDIESVAR) till Hermods, 205 10 Malmö.
Kopian behåller Du själv.
5 Eventuella frågor eller kommentarer med anledning av kursen kan du skriva på **baksidan** av originalet.

Vik här!

Markera dina svar här nedan!

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

Optical Mark Reading System
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Hermods Skola

Handläggare: Gunvor Larsson | Datum: 76-05-03 | Elev registreringsnr: 14706849 | Blad: 1

KENNETH MATTSSON

NORRAGÅRDSV 14
290 71 NÖRRUM

Introduction

Reference to model answers

GRUNDKURS I FYSIK Studieenhet 2 68-240

(A) För varje uppgift som jag kommenterar anger jag dess nummer och det rätta svarsalternativet. I kommentaren får du sedan bl a en sidhänvisning. Har du kursmaterialet och insändningsuppgifterna framme?
(B) Jämför de mönsterlösningar som jag bifogar, med dina egna lösningar. Naturligtvis bör du ägna särskild uppmärksamhet åt de uppgifter som du inte har löst rätt.

Specific comment

1 d Du har föreslagit a.
Ett ämne har alltid lika många elektroner som protoner, men alla dessa elektroner är inte ledningselektroner. Isolatorer saknar ledningselektroner.

(C) Uppgifterna 2-5 behandlar kopplingsscheman och du har klarat av alla! Det visar att du har förstått teorin och kan tillämpa den i nya situationer.

7 c Du tyckte att alt b var det riktiga.
Tiden ska mätas i sekunder, inte i minuter. 1 minut=60 sekunder.

16 c Du har svarat att e är det rätta alternativet.
I ditt alternativ induceras övernuvudtaget ingen ström i ledaren eftersom den inte skär några magnetfältlinjer.

Av 20 möjliga har du 17 rätt.
(D) Resultatet är bra. Du tycks ha fått ett gott grepp om innehållet i den här studieenheten. Det gläder oss.

(E) I det andra häftet har du nog fått lära en mel del matnyttigt. Du läser om de viktiga upptäckterna att elektroner i rörelse ger upphov till magnetfält och å andra sidan att elektronerna i en ledare påverkas av en kraft då ledaren rör sig i ett magnetfält. Jag hoppas att du finner förklaring på en del vardagliga företeelser när du nu har gått igenom hela häftet.

Ditt betyg blir 4.

Specific comment

Vänliga hälsningar

Gunvor Larsson

Concluding evaluation

Hermods Skola

Handläggare: Gunvor Larsson | Datum: 76-05-03 | Elev-nr/referens nr: 14886253 | Blad: 1

INGRID ADOLFSSON

HASSELBACKEV 14
444 00 STENUNGSUND

Introduction

Reference to model answers

GRUNDKURS I FYSIK Studieenhet 2 68-240

Jag hoppas att följande kommentarer kan hjälpa dig att förstå det som eventuellt ännu är oklart för dig i den här studieenheten. Jämför mej insändningsuppgifternas formulering, och slå upp i kursmaterialet efter hand som du får hänvisning till det.
Kontrollera gärna i bilagan med mönsterlösningar att du har tänkt rätt på de uppgifter där du har valt rätt svarsalternativ - även om lösningarna inte behöver se ut exakt så som våra.

1 d Du tyckte att alt b var det riktiga.
Elektronerna rör sig mycket riktigt från minuspol till pluspol men inte med hög hastighet. Strömmen däremot har stor hastighet. Var och en elektron i ledaren börjar långsamt att röra sig på nästan samma gång och därmed fortplantar sig strömmen snabbt. Varje elektrons hastighet är bara några cm/min. - Se figur 10, s 8.

5 b Du har svarat att c är det rätta alternativet.
Ska vi gå runt i krets a och c? Vi går moturs och följer den lilla övre kretsen samt startar vid batteriets pluspol.
I a träffar vi först på en lampa och därefter en till, som vi kan kalla lampa L. Sedan är vi tillbaks vid batteriet. I c stöter vi först på lampa L och därefter en lampa, placerade spegelvänt mot a. I c finns två seriekopplade lampor placerade parallellt över L, precis som i a. Var på ledaren de är placerade spelar inge roll.
a och c är tydligen samma krets. Fortsätt och gå runt kretsarna i b, d och e och jämför med c!

Specific comment

I uppgifterna 6-9 får du räkna en del, bl a på Ohms lag. Du har klarat av alla och det är utmärkt. Både uppgift 7 och 9 kräver att man tillämpar flera samband. Ohms lag får du använda mycket i eläran om du ska läsa mera fysik.

11 b Ditt förslag var a.
Har du missat uträkningen? Vi kan multiplicera med 10 i täljare och nämnare.

$$\frac{1,5}{0,1}\ \Omega = \frac{15}{1}\ \Omega = 15\ \Omega$$

Av 20 möjliga har du 17 rätt.
En mycket bra prestation - och dessutom en förbättring jämfört med förra gången!

I det andra häftet har du nog fått lära en hel del matnyttigt. Du

Concluding evaluation

470811
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Specific comment

läser om de viktiga upptäckterna att elektroner i rörelse ger upphov till magnetfält och å andra sidan att elektronerna i en ledare påverkas av en kraft då ledaren rör sig i ett magnetfält. Jag hoppas att du finner förklaring på en del vardagliga företeelser när du nu har gått igenom hela häftet.

Ditt betyg blir 4.

Vänliga hälsningar

Gunnar Larsson

4701:1

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Hermods Skola

Handläggare
Gunvor Larsson

Datum
76-05-03

Elev nr/födelsedatum
15679509

Blad
1

LARS SJÖLANDER
MULTIPOST DISTR AB
BOX 21024
200 21 MALMÖ

LENNART BLOM

MALMÖ

Introduction

MATEMATIK FÖR VU-UTB Studieenhet 5 67-162

(A) Den här studieenheten har du lyckats fint med.
(B) Jag bifogar också mönsterlösningar till uppgifterna. Det kan ju vara intressant att jämföra med författarens förslag till hur uppgifterna ska lösas, samtidigt som du får en smula repetition.

Av 15 möjliga har du 15 rätt.
(C) UTMÄRKT!

Ditt betyg blir 5.

Reference to model answers

Vänliga hälsningar

Gunvor Larsson

Concluding evaluation

Hermods Skola

Handläggare: Gunvor Larsson | Datum: 76-05-03 | Elev-nr/referens nr: 14918674 | Blad: 1

Specific comment

BJÖRN LARSSON

VIKINGAV 69 B
852 46 SUNDSVALL

Reference to model answer

Introduction

GRUNDKURS I FYSIK Studieenhet 3 68-240

Ⓐ Dina lösningar till insändningsuppgifterna i denna studieenhet har nu granskats. Resultatet är glädjande.
Ⓑ Det kan ju trots allt tänkas att du någon gång inte varit absolut säker på lösningen utan valt det mest [illegible]nolika alternativet. För att du ska kunna klara en sådan uppgift i fortsättningen utan stöd av givna svar kan lösningsbilagan nog vara till en viss nytta.

Ⓒ I uppgift 6 behandlas avstånd till åskväder. På s 13 står att mullret uppstår samtidigt som vi ser blixten. Du kanske har funderat över varför vi inte har hört att ljuset väl tar viss tid för att nå oss? Längre fram i häftet ser du att ljuset färdas med hastigheten 300 000 km/s. Ska vi se efter hur lång tid det skulle ta ljuset att nå oss om åskvädret befinner sig 3 km bort från oss?

Vi har att hastigheten = $\frac{\text{vägen}}{\text{tiden}}$, vilket ger 300 000 = $\frac{3}{\text{tiden}}$

Tiden blir då 0,00001 s, och är alltså försumbar i detta sammanhang.

Ⓓ Uppgifterna 6-8 och 10 i detta häfte behandlar rörelseproblem och du har rätt på alla. Redan i första häftet visade du dig klara av alla rörelseproblem och en del av dem var svåra. Du har arbetat mycket bra och jag tror att du ska få gott utbyte av sista häftet eftersom du har så goda grunder.

Av 20 möjliga har du 20 rätt.
Ⓔ Du tycks ha lagt ner ett mycket omsorgsfullt arbete på den här studieenheten. Gratulerar till resultatet!

Ditt betyg blir 5.

Vänliga hälsningar

Gunvor Larsson

Concluding evaluation

Specific comment

470111
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Hermods Skola

Handläggare: John A Bååth | Datum: 76-05-03 | Elev-nr/referens-nr: 14766018 | Blad: 1

BERTIL NYMAN

FOLKUNGAV 12
175 30 JÄRFÄLLA

Introduction

Specific comment

ARBETSLEDNINGENS PSYKOLOGI Studieenhet 2 65-278

Jag hoppas att följande kommentarer kan hjälpa dig att förstå det som eventuellt ännu är oklart för dig i den här studieenheten. Jämför med insändningsuppgifternas formulering, och slå upp i kursmaterialet efter hand som du får hänvisning till det.

Att det vid en intervju är viktigt att också den intervjuade får tillfälle att ställa frågor var vi överens om i studieenhet 1 (uppgift 12). På samma sätt bör man tillåta och rentav uppmuntra frågor vid introduktion och instruktion. Också detta tycks du ha fullt klart för dig, av dina svar på uppgifterna 3 och 5 att döma - bra!

8 d Ditt förslag var a.
Kraven i samtliga svarsalternativ är i och för sig vettiga. Den viktiga likheten mellan exemplet och den situation som ofta uppstår i utbildningssammanhang är emellertid att man inte gjort (tillräckligt) klart vilket mål man har. - Se s 22 -23 ('All utbildning måste ha ett klart preciserat mål').

10 a Du valde svarsalt d.
Det är viktigt både att eleven lär sig rätt metod och att inlärningstiden inte blir för lång. Effekten av inlärningen är alltså beroende av såväl hur lång tid inlärningen tar som hur säker den är. - En inledande orientering om syftet med arbetsuppgiften kan göra eleven mer motiverad, dvs mer intresserad och mottaglig för instruktion. - Se s 27-29!

Specific comment

12 b Du har föreslagit a.
Det är viktigt att man fastställer kvalitetskraven och informerar om dessa vid instruktionen. - En instruktionsenhet bör rimligtvis inte omfatta alla arbetsmomenten. - Se s 31-33!

Information är ett av nyckelorden i den här studieenheten. Uppgift 10 gällde ju just det lämpliga i att ge förberedande information. Men också uppgift 1 och 15 har handlat om de anställdas behov av information i olika sammanhang. Förbise aldrig det behovet!

Av 15 möjliga har du 12 rätt.
Visserligen kan du kanske ännu bättre, men du har i stort sett uppnått målet för den här studieenheten. Som du ser krävs det ytterligare lite tätningsarbete, innan kunskaperna håller.

Ditt betyg blir 3.

Concluding evaluation

Vänliga hälsningar
John A. Bååth

Hermods Skola

Handläggare: Gunvor Larsson | Datum: 76-05-03 | Elev-nr/referens nr: 14913683 | Blad: 1

KURT-OVE ERIASSON

BOX 418 HANDSJÖN
840 24 ÖVERTURINGEN

Introduction

Reference to model answers

MATEMATIK FÖR VU-UTB — Studieenhet 9 — 67-162

(A) (B) För varje uppgift som jag kommenterar anger jag dess nummer och det rätta svarsalternativet. I kommentaren får du sedan bl a en sidhänvisning. Har du kursmaterialet och insändningsuppgifterna framme? Jämför de mönsterlösningar som jag bifogar, med dina egna lösningar. Naturligtvis bör du ägna särskild uppmärksamhet åt de uppgifter som du inte har löst rätt.

4 a Du har svarat att b är det rätta alternativet.
Ser man med ögonmått kanske det verkar som om rektangeln har störst area. Men figurerna är inte ritade i samma skala.
5 cm i rektangeln är mycket längre än 4,8 cm i cirkeln.

5 a Ditt förslag var d.
När du kvadrerar stora radien 2x så ska <u>både</u> 2 och x kvadreras. $(2x)^2 = 2x \cdot 2x = 4x^2$. Vi markerar att både 2 och x ska kvadreras genom att sätta parentes omkring dem.
Har du sett efter i figuren vilken area $\pi \cdot x^2$ är? Jo, den lilla vita cirkelns area. Denna cirkel har ju radien x. Du kan alltså inte beräkna differensen mellan de två radierna och sedan behandla denna differens som om den vore radie i en ny cirkel. Nej, beräkna varje area för sig och subtrahera sedan.

7 b Du valde svarsalt c.
Försök att rita upp en rätvinklig triangel med kateterna 5 m och 7 m samt med en hypotenusa på 12 m. Det går inte ihop, som du ser. Mellan A och B är det 12 m om du går via C.
Då kan inte det kortaste avståndet - som är den räta linjen - mellan A och B vara lika långt.
Hur du ska gå till väga ser du i Svar och lösningar.

Specific comment

9 b Du har föreslagit c.
Ur likheten $x^2 = 2a^2$ får du att x är kvadratroten ur <u>hela</u> höger led, dvs $x = \sqrt{2a^2}$.

(C) Ser du att triangeln i uppgift 9 är en halv kvadrat? BC är diagonal i denna kvadrat och dess längd är då $\sqrt{2a^2}$.

10 d Du tyckte att alt c var det riktiga.
Hypotenusans längd i kvadrat blir $2a \cdot 2a = 4a^2$. Ena katetens längd i kvadrat blir a^2. Differensen mellan dessa är $4a^2 - a^2 = 3a^2$. Mellanleden och slutet ser du i Svar och lösningar.

Triangeln i uppgift 12 har sidorna 6 cm, 8 cm och 10 cm. Halverar vi varje sida får i sidorna 3 cm, 4 cm och 5 cm. Egyptierna kände till

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Specific comment

(D) en sådan figur och därifrån fick pytagoreerna denna 'gyllene' triangel. Då man undersökte andra rätvinkliga trianglar upptäckte man den sats som fick Pytagoras namn. Pytagoras själv lär ha kommit på den, och han blev så överväldigad över dess skönhet att han offrade en oxe åt gudarna.

Av 12 möjliga har du 7 rätt.
(E) Det är ett ganska bra resultat, men du bör naturligtvis tänka igenom de avsnitt som du nu har fått kommentarer till och repetera dem.

Ditt betyg blir 3.

Vänliga hälsningar

Gunnar Larsson

Concluding evaluation

4701:1
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Hermods Skola

Handläggare	Datum	Elev nr/referens nr	Blad
Gunvor Larsson	76-05-03	15560378	1

GULLI MATSSON

BOX 144
790 56 VANSHUS

MATEMATIK FÖR VU-UTB Studieenhet 8 67-162

Du har tyvärr inte lyckats så bra på den här studieenheten som vi skulle önska. Vi tycker därför att du bör göra ett nytt försök. Bättre kan du säkert!

Vi bifogar en ny lösningsblankett och väntar alltså på dina lösningar. Kontrollera för säkerhets skull noga att du använder blankett för rätt insändningstillfälle och fyller i den på rätt sätt.

Lycka till!

Vänliga hälsningar

Gunvor Larsson

Hermods Skola

Handläggare: John A Bååth | Datum: 76-05-03 | Elevnummer: 14913784 | 1

GUNNAR NYBERG

TIMMERV 2
870 15 UTANSJÖ

Introduction

ARBETSLEDNINGENS PSYKOLOGI Studieenhet 4 65-278

(A) Mina kommentarer blir inte särskilt långa, tack vare kvaliteten på dina lösningar. Har du kursmaterialet till hands?

2 d Du har valt det rätta alternativet.
Den här uppgiften innehåller en liten fallgrop, som du lyckligt har undgått: Situation a är naturligtvis lättast att klara upp, men här föreligger ju ingen motivkonflikt - man tvekar nog inte vid det valet!

8 a Rätt!
Ditt svar tyder på psykologisk känslighet, en värdefull ledaregenskap.

Det kan tyckas lovvärt att man försöker andra på den stressdrabbades attityder. Chansen att lyckas är dock inte så stor. Riskerna med psykologiskt 'kvacksalveri' är däremot betydande. - Se s 25-27.

12 b Du tyckte att alt a var det riktiga.
Det är i regel olämpligt att låta de utländska arbetarna bilda en egen grupp. De får ju då färre tillfällen att träna sig i svenska - vilket har stor betydelse - och de får sämre möjligheter att bli bekanta med svenska arbetskamrater. Ömsesidig information om seder och förhållanden (c och d) bör vara av stort värde för den gemensamma anpassningen.

Av 12 möjliga har du 11 rätt.
(B) Är du själv nöjd? Jag tycker i varje fall att det är en god prestation. Mycket bättre kan det ju inte bli.

(C) Därmed har du slutfört den här kursen. Jag hoppas att du har haft gott utbyte av den - både nytta och, kanske, en smula nöje. Du är välkommen med synpunkter!

Ditt betyg blir 4.

Det sammanfattande betyget på hela kursen blir 5.

Vänliga hälsningar

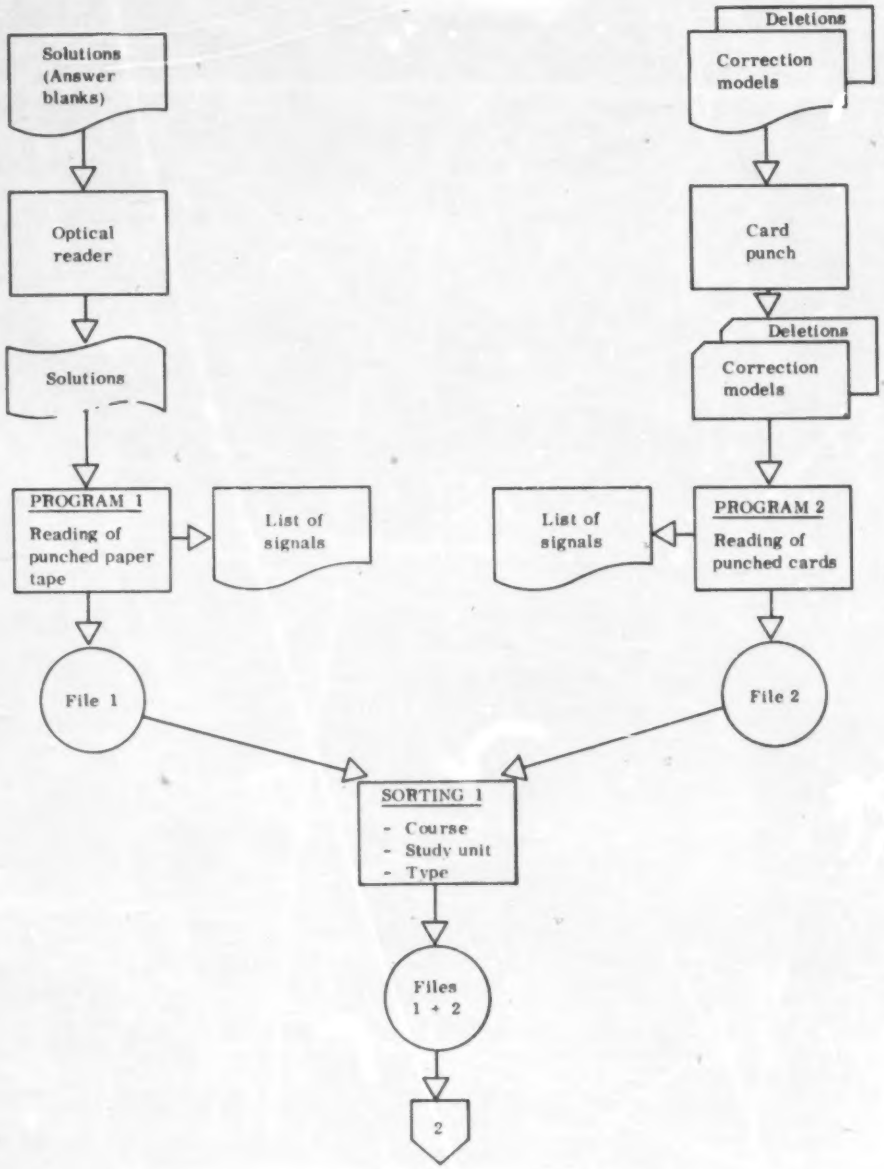
John A. Bååth

Final comment

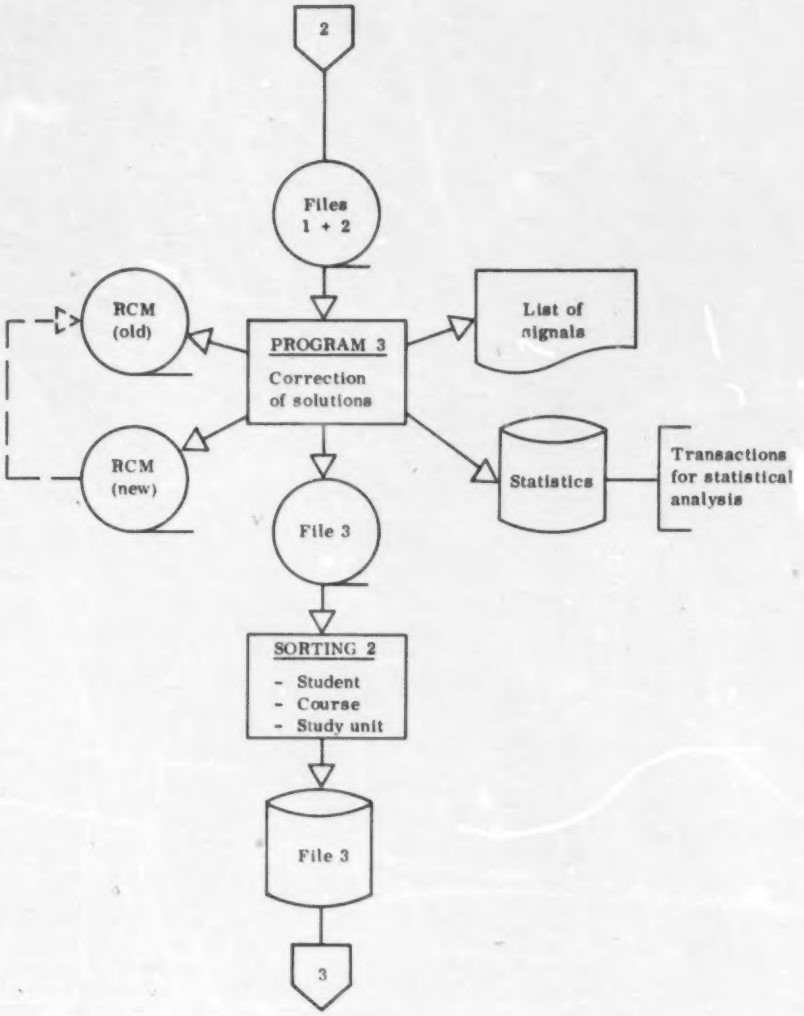
Concluding evaluation

CADE flowchart

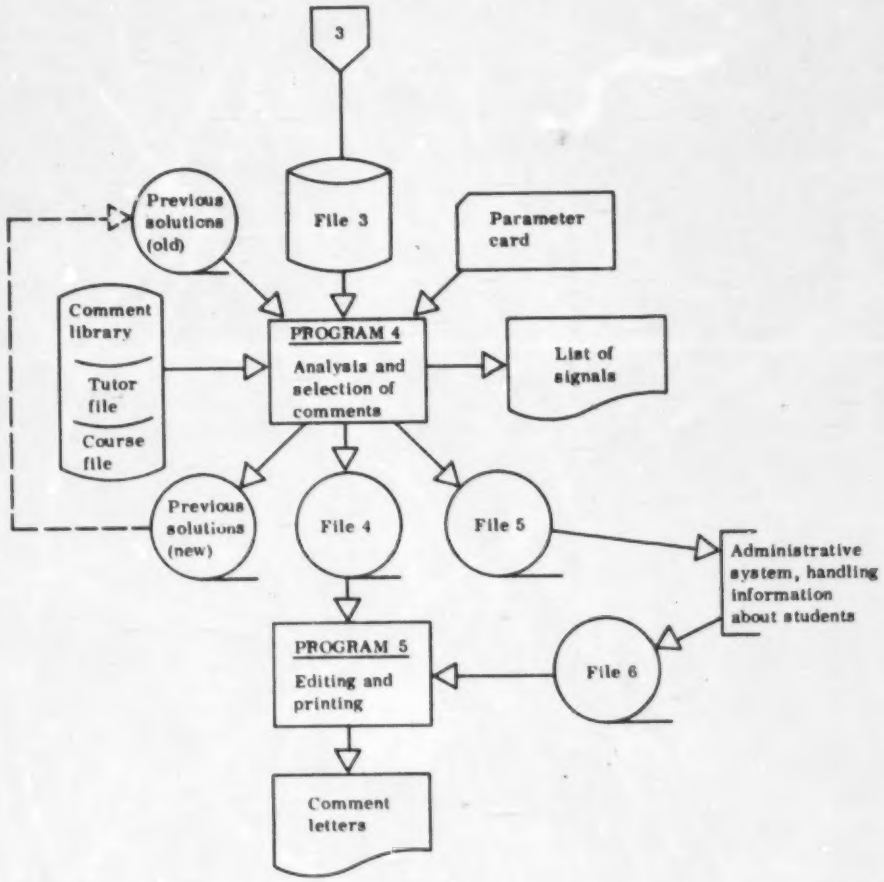
1 Input



2 Correction



3 Analysis and printing



4 Creation of comments